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THE EAST AFRICAN AGRICULTURAL JOURNAL

Issued under the Authority of the East African Governors' Conference and published every three months—July, October, January, April. Volume consists of four issues (commencing July issue).

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Assistant Editors: R. E. Moreau, Amani; Mrs. Holmes Jackson, Department of Agriculture, Nairobi.

FOREWORD

Some readers must have been surprised by the absence in recent numbers of direct reference to agricultural war policy or war work. Several factors have contributed to this effect. A potent one is that the relatively long (quarterly) intervals at which the Journal appears make it unsuitable as a vehicle for declarations of, or guides to, policy that it is desirable to "put across" speedily. A contribution on the possibilities of bacon export, for example, became obsolete before it could be printed. Another factor is that although work on problems of war supplies is proceeding in a number of most interesting directions it has not as a rule reached the stage of being ripe for publication, even if that were, from the censor's point of view, entirely unobjectionable.

One of the minor problems of wartime supplies to which East Africa may be able to make some contribution is that of drug plants. Their cultivation was a well-organized business in some of the European countries from which supplies have been virtually cut off. The U.S.A. has been affected, although in a lesser degree than the United Kingdom, and it is now several months since an inquiry was received from the U.S.A. as to the possibility of obtaining drugs in the pharmacopœia, or substitutes for them, from East African plants. A reply to such an inquiry involved a good deal of research in the literature, and the comprehensive list by Mr. P. J. Greenway that is printed in this number (page 127) provides a useful basis for any attempt to utilize indigenous and naturalized plants. It must be emphasized that in most cases where it seems likely that substitutes are available, fairly complicated chemical work will probably be necessary to establish the degree of suitability. Moreover, expensive apparatus is often needed to produce the actual drugs in an acceptable state.

While the material for this number was being prepared for the press we received *Nature* for 5th October, which contained a note of direct interest in this connexion. It is reprinted immediately after Mr. Greenway's contribution. An "official body representative of the medical profession" has recommended that a list of drugs, which is given, should be produced in the Empire. An editorial note has been added that indicates very briefly some of the potentialities and the limitations of East Africa so far as this list is concerned; but the provisional and preliminary nature of this note cannot be emphasized too strongly. It is proposed to publish more detailed information in subsequent numbers of the Journal. Meanwhile, anyone interested should apply in the first instance to their local Director of Agriculture. It is to be hoped that this is one of the sections of the war supplies effort in which concerted plans will be made for the Empire as a whole, since it is with this type of material that overproduction is most to be feared.

An important article in this number is that in which Mr. S. H. Wimbush describes the South African wattle industry. In a subsequent part he will compare the Kenya industry and adduce valuable conclusions and recommendations. In passing, it may be noted that one point in which Kenya is more favourably placed than South Africa is that labourers' wages are about half; though this may in part be off-set by the better physique of the South African, employed, moreover, always on task-work. In South Africa wattle-growing is a considerable, but not a highly profiable, industry, more suitable for the "big man" and the company than for the ordinary farmer. Its very existence depends on successful competition with cheap sources of tannin, both natural and synthetic, the most serious competitor at present being South American "Quebracho." Any development of the industry can only

come through extending the use of wattle products, including timber and charcoal. For such an end the necessity of research is fully recognized. The industry as it exists to-day is a striking example of the beneficial results that follow from the application of research, mainly in the matters of thinning practice and bagworm control. Now South African wattle-growers propose to establish, and support, a research station especially for their own problems. Another recent development is the production of creosoted wattle poles as a substitute for more expensive materials. Such poles are said to remain sound for twenty years and more after treatment in a proper creosoting plant.

Another feature of especial interest in this number is the study by Dr. W. D. Raymond on the nutritive value of cassava and the closely linked article by Mr. and Mrs. Culwick on native nutrition and agriculture. Raymond's study, which goes far to revolutionize ideas on the dietetic value of cassava, shows how much there is still to be learnt about one of the most publicized of food crops. The Culwicks, drawing together the agricultural and sociological threads of the problem, consider group by group what the human body needs, fats, protein, vitamins and so on, what local sources exist for these needs, and how they could be supplemented. Their treatment of this most complex problem has an engaging practicality and an enviable breadth of grasp. They are not blind to the difficulties in the way of desirable changes; they are concerned that certain changes consequent on the introduction of new food crops, though filling the native belly more easily and surely, may provide less adequately for the vital working needs of the body. "It is sheer waste of time making two ears grow where one did before unless the two are more valuable than the one they replace." Finally, they stress the importance of meeting the native taste, a point so often neglected in discussions of what the African ought to eat. However clever and reiterated the advertisement that "——— is good for you," and however good in truth the article may be, its sale will not go well unless it fits the public taste.

Actually the choice of food available to the African public is likely to widen greatly, as will be seen from the list of food crop varieties available for distribution from Amani, which is distributed with this number. In it will be found many introduced varieties that have made a name for themselves abroad. It is not suggested, however, that because of this they will necessarily succeed under particular conditions in East Africa. It is intended that they should serve as a source from which growers in East Africa can obtain seed for multiplication and subsequent trial.

Part III of the Termite series is unavoidably held over till the April number.

CORRIGENDUM

The scale of Plate II of the October number (facing page 67) should have been shown as "7/10ths natural size".

FOREST SOIL

Looking at the soil as we walk, where it is exposed by the roots of a fallen tree, or where there is an old gravel pit, the question occurs whether forests, managed as they are in old countries, ever really increase the fertility of the earth? That decaying vegetation produces a fine mould cannot be disputed; but it seems here that there is no more decaying vegetation than is required for the support of the trees themselves. The leaves that fall—the million million leaves—blown to and fro, at last disappear, absorbed into the ground. So with quantities of the lesser twigs and branches; but these together do not supply more material to the soil than is annually abstracted by the extensive roots of trees, of bushes, and by the fern. If timber is felled, it is removed, and the bark and boughs with it; the stump, too, is grubbed and split for firewood. If a tree dies it is presently sawn off and cut up for some secondary use or other. The great branches which occasionally fall are some one's perquisite. When the thickets are thinned out, the fagots are carted away, and much of the fern is also removed. How, then, can there be any accumulation of fertilizing material? Rather the reverse; it is, if anything, taken away, and the soil must be less rich now than it was in bygone centuries. Left to itself the process would be the reverse, every tree as it fell slowly enriching the spot where it mouldered, and all the bulk of the timber converted into fertile earth. It was in this way that the American forests laid the foundation of the inexhaustible wheat-lands there. But the modern management of a forest tends in the opposite direction—too much is removed; for if it is wished to improve a soil by the growth of timber, something must be left in it besides the mere roots.

Richard Jefferies, *The Open Air.*

GOVERNMENT PARTICIPATION IN AGRICULTURE*

The intrusion of active government interest in agricultural production and marketing in Australia is comparatively recent and, in most industries, has had its beginning in measures designed to prevent, circumscribe, or eradicate outbreaks of disease among economic plants and animals. The fundamentals of ætiology and epidemiology were established upon a sound experimental basis during the latter half of last century and legislative measures for the control of disease naturally followed. Against such measures (particularly in the rather innocuous form in which they have often been enacted and administered) there was no opposition in principle. The community at large appreciates the fact that the defences against contagious diseases cannot be allowed to depend for their efficacy upon the whim of the individual, but that responsibility and protective action must operate on a community basis. Indeed, this form of collective action is accepted in principle by even the most rugged individualists.

Legislation designed to control plant diseases was followed, in Queensland at least, by legislation prescribing minimum, or label, standards for commodities commonly purchased in bulk by farmers; for example, viability of seeds and constituents of fertilizers. Apart from the possible dishonest merchant, whose individualism had become unduly rugged, there could be little well-founded opposition to the principle and application of such laws. Indeed, when abroad, one has often been amazed to find how slow some other countries had been to adopt a similar policy in this matter.

Concurrently there developed a certain amount of legislation designed to protect the purchaser and consumer of agricultural products; this involved the adoption of minimum grades of quality and certain standards of hygiene under which agricultural products should be prepared, packed and delivered. Although perhaps not sought by the producers, such legislation can scarcely be opposed in principle—nor in practice if the prescribed standards may be reasonably attained.

At this stage, however, we reach the point where the further regulation of production and marketing gives rise to energetic and even bitter controversy.

The farmer is by personal inclination an individualist. A long and close association with primary producers has convinced me that most men assume the arduous work and uncertain reward of farming primarily for the sake of the satisfaction of "being their own bosses." The farmer's attitude to social questions will be influenced then, consciously, by the individualistic concept.

It is often claimed that, provided the rights of fellow citizens are adequately safeguarded, there is no ethical justification for the intrusion of any outside body into the domestic economy of an agricultural holding (or any other business, for that matter); that, subject to this proviso, the producer should be allowed should he so desire, to proceed without let or hindrance to economic disruption in the manner most congenial to himself.

With this claim I find myself in full accord, but perhaps I would not be in full accord with many of the claimants in the interpretation of that limiting clause "provided the rights of fellow citizens are adequately safeguarded". In general, however, my summarized personal view is that the amount of ethically justifiable regimentation of any industry is to a considerable extent dependent upon the degree of economic self-sufficiency of that industry.

In the days of small isolated communities, when persons traded by a simple system of barter, a farmer stood or fell by his own efforts; if his produce was unsatisfactory he, and he only, suffered in consequence. In the present-day world of large communities and vastly expanded volume and range of production, the manipulation of exchange of goods has long passed from the individual to the community and, as far as the export and import of commodities is concerned, such exchange has become a matter for national negotiation and responsibility.

In the case of an exportable surplus of produce, whether or not sold by international arrangement, the standard of excellence, or otherwise, of the produce ceases to be solely a matter for the contributory producers but becomes a matter affecting the welfare of the nation as a whole. To quote a specific instance: The financial returns from Australia's exportable surplus of wool are an integral factor in the maintenance of the solvency of this Commonwealth; any action or omission which reduces the saleability of that exportable surplus or reduces its value, will react not merely upon those engaged in the wool industry, but upon the welfare of every citizen of this

* Extracted from an article by A. F. Bell, Deputy Director, Bureau of Sugar Exper. Stations, Queensland in *J. Australian Inst. Agr. Sci.* Vol. 6 (3) pp. 126-136, 1940.

Commonwealth. Surely then the Government of the country is justified in taking such legislative action as is necessary to preserve such certain minimum standards of quality as will maintain the exchange value of the wool.

Of paramount importance, perhaps, in the question of the ethics of government participation in agriculture is the so-called artificial raising of price levels for primary products by their acquisition at fixed minimum prices, adjustments of exchange rates, payment of bounties and the like. There are, of course, an increasingly large number of primary products which are sold at such a stabilized price level instead of depending upon the age-old basis of supply and demand, with or without bull and bear market tactics. In other words, the community, through the Government, guarantees to the primary producer a steady monetary return for his products which is in excess of the average return which could be obtained in the open market.

But in return for such guarantees the primary producer must inevitably surrender a degree of his independence or individualism. The local consumer has now become a partner in the business of primary production and is justified in ensuring a *quid pro quo* in the form of legislative control. Since he pays some of the piper's fees he is entitled to call some of the tune; he becomes directly interested in seeing that crop production is controlled within certain limits and, particularly, he now becomes materially interested in the relative efficiency of the primary producers and primary industries. That is to say, the community at large, in return for its contribution to the at least partial maintenance of a particular primary industry, now demands some share in the management of that industry and ensures that share by legislation.

This appears to be the hurdle at which individualists baulk. They can accept the principle of stabilized prices but do not concede that it entails their surrender of what they consider an inalienable birthright.

In latter years the world has heard much of soil erosion, and this question opens yet another phase of legislation affecting primary production, namely land tenure. It will, I think, be generally conceded that if a man buys a piece of apparatus he is more or less entitled to treat it to such attention or neglect as his mood decrees; it is but a transient material possession and may readily and gladly be replaced by industry. The ownership of land is a different matter. Land cannot be replaced or re-created, and therefore it would appear but reasonable to postulate that ownership of land is not absolute, but rather that the owner holds the land in trust for future generations. If we accept that viewpoint, and I think we must, then it is a necessary corollary that we must believe that the Government should take such measures as are necessary to ensure that the heritage will be held inviolate and the trust not abused.

Finally, a dispassionate observer will be forced to admit that during the past twenty years the initial requests for regulating legislation in primary industry have usually come *from the primary producers themselves.* True, they may not have correctly visualized what they were requesting, nor perhaps realized the inevitable consequential reactions resulting from the implementing of their requests; or they may have received much more or much less than they actually requested. The increasing immensity of production and the increasing complexity of distribution and exchange of primary products brings more and more primary producers, in their perplexity, to seek government aid for the "protection" of their particular industry. Thus most of the modern agricultural legislation is "protective" in intention, but protective legislation cannot be a purely external device; it must necessarily overhaul, and sometimes reform, the internal structure, and in the doing thereof some people are displeased.

Summarizing these rather random and generalized observations, we see that there is a great deal of fundamental justification for the admittedly rapidly increasing extent of Government participation in agriculture. Greater knowledge of methods for the control of plant and animal diseases must be followed by more specific and more positive legislative measures; barter and exchange have moved from an individual to a national basis—with all the structural changes that this implies. The stabilization of prices of primary products, with the assistance and at the expense of the consuming community, confers on the community the status of a partner with a voice in the management of affairs. Primary producers themselves have been responsible for the initiation of crop control legislation.

[*Note.*—The above extract is the preamble to a discussion of the Queensland sugar industry, one that is of especial interest to the agricultural legislator and economist, because about the best production figures in the world have been achieved along with a control of the individual producer that can hardly be exceeded anywhere.—ED.]

A COMPARISON OF WATTLE GROWING IN NATAL AND IN KENYA

By S. H. Wimbush, B.A., Assistant Conservator of Forests, Kenya Colony

(*Received for publication* 10*th June,* 1940)

PART I—NOTES ON SOUTH AFRICAN PRACTICE

Distribution and climate

There are in South Africa about 500,000 acres of wattles which are being grown for the production of tan bark—380,000 acres in Natal and 110,000 acres in the Transvaal. The two species under cultivation for this purpose are *Acacia mollissima* Willd. (Black Wattle)[1] and *Acacia decurrens* Willd. (Green Wattle). The wattle-growing area is mostly confined to the lower eastern slopes of the Drakensberg range in Natal and the Eastern Transvaal between 2,000 and 4,000 feet above sea-level and at distances of 10 to 100 miles from the seaboard of the Indian Ocean.

The rainfall over this area is generally between 30 and 45 inches per annum, the greater part of which falls during the summer months, November to March. Much cloudy weather occurs in the latter half of November, December, January and February in normal years. During these spells of cloudy weather country lying above 3,000 feet is enveloped in dense mist or fine rain, and estates situated within this mist belt thus obtain a considerable advantage in suitable moisture conditions over other estates at lower altitudes, even though the recorded rainfall may be about the same.

Wattle is being grown successfully on soils overlying dolerite, sandstone, shale and conglomerate. The land before being planted to wattle was of the open grassland type. I did not come across any estate where wattle was being grown in old forest soil.

Itinerary

I spent a week in November, 1939, being taken round by the Forest Research Officer stationed at Pietermaritzburg, Mr. R. P. Stephens, who showed me wattle plantations on estates in different parts of the Natal midlands and took me to Durban to see bark grading in progress. On some of the estates I was able to see the Forest Research Officer's experimental plots, on which present South African silvicultural policy is based.

Silvicultural policy

Wattle research in South Africa has brought out the following basic facts:—

(1) Tannin content of wattle bark is a function of bark thickness; the thicker the bark the higher the tannin content.
(2) Bark thickness is a function of diameter for any given site.
(3) Diameter growth depends on the general vigour of the tree.

It has been found in South Africa that wattles do not easily regain vigour lost from any causes such as overcrowding, competition for soil moisture by weeds, or defoliation by insects. Tree vigour must therefore be jealously maintained from the very start; this can only be achieved by early selection of the most vigorous individuals from the initial crop of seedlings, and by destroying all other vegetative growth, such as other seedlings and weeds, which may compete for soil moisture with the selected trees. This entails early and heavy thinning of the wattle crop, combined with frequent weeding until such time (generally 12 to 18 months old) as the trees can naturally suppress the ground vegetation. Craib [1] states that "the first year in the life of a wattle plantation is of basic importance, for upon it will directly depend the ultimate yield." These are the principles on which South African silvicultural policy in wattle-growing is now based.

Silvicultural practice in plantations

I will not describe this in detail as it has already been done elsewhere [1], but I append some notes on plantation management which I made during my tour of the industry.

(*a*) *Hoeing out perennial weeds*

Before the standing crop of mature wattle is felled, perennial grasses are hoed out by hand. In some cases even the new wattle rows are laid out and seed sown before felling. The supposed advantage is that no time is wasted between the removal of the mature crop and the initiation of the new one, but it is of doubtful value.

[1] The correct name of the Black Wattle is apparently *A. decurrens* Willd. var. *mollis* Lindl.—*Ed.*

When the trees are felled it is part of the felling gang's task to pile the brushwood in lines (generally 40 to 50 feet apart) which have been roughly staked out along the contours under the supervision of the overseer. The distance between brushwood piles should be a multiple of the proposed distance between planting rows.

(b) Re-seeding after felling

I was surprised to find that so much re-sowing is done instead of relying on natural regeneration. I think it is mainly on estates lying below the mist belt or on other average or poor sites. On Cramond Estate, in the Albert Falls district, which lies just below the general level of the mist belt, re-sowing is the rule. A single-row seed-drill drawn by a mule will run a furrow close to the brushwood pile; the boy who leads the mule will then walk back along this same line, leading the mule abreast of him by a stick cut to represent the correct width between rows (plus a foot or two to give the boy a purchase). He then returns up the second furrow, still leading the mule abreast but on the other side; and so on, row by row, until the next brushwood pile is reached.

Another method, practised on the Natal Tanning and Extract Company's Fairfield Estate, is for the overseer with the help of a few boys to stake out the rows with light sticks some 10 to 15 yards apart in the row, parallel with the brushwood piles. When the time comes for sowing, each labourer takes his row equipped with a hoe and a bag of wattle seed. At every yard or pace along his row he hoes a spot, drops in some seed, covers it with soil, and moves on one pace, where he repeats the operation, and so on to the end of his row.

Distance between rows

Rows 6 to 9 feet apart are the rule; from what I saw, 6 to 7 feet rows are usual. The argument against wider rows is that they sacrifice selection and even spacing in the early stages for the doubtful benefits of mechanical weeding between the rows, which is only strictly feasible for three to four months after germination of the young wattle seedlings, i.e. one, or possibly two, operations. Mechanical cultivation later than this will damage the rapidly advancing roots of the wattle. As at least two more weedings by hand-hoeing will be necessary, it seems doubtful whether it is worth while doing the first operation by mechanical cultivator.

Manuring

The use of superphosphates seems to be standard practice, at any rate among the more progressive growers.[1] The usual application is 200 lb. per acre, applied at the beginning of each rotation.

Weeding

Properly managed plantations are kept scrupulously free of weeds and unwanted wattle seedlings until the selected trees reach 10 to 12 feet high. This entails three or four weedings in the first year. The setback to height growth and vigorous appearance due to delayed weeding for several months was most remarkable in plantations where I saw this, and fully confirmed the importance laid on weeding by the Department's published policy. An important point in connexion with weeding is that the bigger the wattles the lighter must be the hoeing to avoid damaging the roots.

Pruning

This is now done, at any rate by the more progressive growers. The first pruning takes place when the trees are about 6 feet high; it entails the removal of any branch which appears to be competing for the lead. In a normal plantation only about one tree in three has to have one branch removed, so the operation is not expensive, but must be done with some intelligence. The same operation is repeated when the trees reach about 12 feet. If in the meantime froghopper has obliterated the leading shoot, a new leader must be selected and the other competing branches removed by pruning. Sharp secateurs are used for these prunings.

Thinning

Craib [1] lays down "The aim is to secure, within a few months after natural or artificial seeding, approximately 800 uniform, evenly spaced, full crowned, well-rooted and rapidly growing seedlings per acre." This is the first step. The principle is then to continue thinning out these 800 trees every two or three months until for any reason (such as drought, pests, disease, hail) crown vigour is seriously affected. Thinning must in that case be stopped, at any rate until it is seen to what extent crown vigour is recovered; a good recovery may enable some further thinning to be made. Failing any such calamity, thinning is continued until about 250 trees per acre are left; these should then be about 7 to 10 feet high.

[1] On estates where the brushwood has been burnt year after year, a practice still not wholly extinct, the fertility has fallen very low.—*Ed.*

Craib [1] states that "The very drastic thinning recommended above is based on the fact that the increased height and diameter growth of stands thinned heavily and early more than compensates for the loss in number of stems per acre." It should be added that this compensation is not only in the quantity of the yields of tan bark but also in the quality; the much thicker bark produced by such trees has a higher tannin content than would be found in smaller trees grown in a denser stand on the same site, and therefore such bark is of higher grade and fetches a better price per ton.

I was interested to find out at what final densities growers are now maturing their plantations, but as the new silvicultural policy has only been in practice for five or six years I was not able to see any mature crop which had been treated from the start on the new lines. The six-year-old crops that I saw carried varying numbers of trees, ranging between 180 and 350 trees per acre. All growers seemed agreed that standard practice must include spacing to 800 seedlings per acre at 3 feet and not more than 400 at 12 feet. On Cramond Estate trees are thinned to 250 per acre at 10 to 15 feet; the sites here are only average. On Windy Hill Estate in the mist belt, where sites are good, plantations still carry 350 trees per acre at 12 feet, and little or no thinning is done later.

The Forest Research Officer favours a final thinning down to 180 to 200 trees per acre. This can only be done if the trees have retained full vigour since the thinning to 250 trees per acre at 7 to 10 feet. Provided this is the case, then the final thinning on average sites should be made when the trees reach 20 feet; the thinnings will therefore not be large enough to be saleable. But on good sites (in the mist belt), where wattle has greater powers of resistance to loss of vigour from mutual suppression or other causes, the Research Officer recommends delaying the final thinning until the trees have saleable bark; this will probably be at about 40 feet in height. (The question as to when bark becomes saleable is discussed in Part II of this article, and will largely determine the feasibility of this delayed thinning.)

Stripping

I was surprised to find that in stripping the bark from breast height on the standing tree down to ground level the usual practice of pulling down the bark until is comes free at the root-collar was not always being done. On one estate (Windy Hill, Wartburg), it is the practice to chop the bark round the base of the tree as well as at breast height, so as to leave on the stump the bark adhering to the root collar. We in Kenya have always believed that this bark around the root collar is the richest in the tree, but I was informed by the estate manager that the manufacturers have objected to this bark on account of its dark colour.

Williams [2] makes no mention of this. He found that "There is no continuous decrease in colour as we go up the tree. . . . It seems, however, that the colour is deeper in the middle sections and decreases as we go up or down the tree." The differences, however, were slight, and would tend to be masked by the action of drying and weathering.

I doubt whether there is much importance in this apparently new theory of the manufacturers, but I mention it as one of the points that struck me at the time. It may be that the incidence of gummosis on this particular estate may have something to do with it. Some bark showing incipient disease may have been the cause.

Drying

The Forest Research Officer, experimenting on the Windy Hill Estate, found that drying racks lying at an angle of 45 degrees to the horizontal are most efficient for drying bark. A flatter angle tends to check upward air currents through the bark, while with a steeper angle the sun's rays strike the bark too obliquely and also the bark tends to fall off the racks.

Yields

Under the old methods of management, combining delayed early spacing of seedlings with light thinnings throughout the rotation, three tons of dry bark (equivalent to six tons of green bark) per acre was the average yield from Natal plantations. No figures are yet available for yields under improved silvicultural treatment, combining early spacing out of seedlings, intense weeding and early thinning of the young trees to about 200 to 300 per acre, but it is already certain that very much heavier yields of both bark and wood will be obtained.

Yields of wood are approximately in the ratio of four tons for every ton of dry bark.

Marketing of wood

The main market is for mining timber. For mine props, straight lengths of 6 to 10 feet must be obtainable; such lengths cut from the medium diameter portion of the tree are sold

as round props; the larger boles are slabbed by saw on two sides and crosscut into short lengths for mat-packs; the thin ends of the boles (under 4 inches diameter) are crosscut into short firewood billets. Mining timber is valued at 8/- to 15/- per ton on rail.

Pests and diseases

(*a*) *Bagworm* (*Acanthopsyche junodi*) is the most serious of the insect pests of wattle in South Africa. Considerable research into this and other pests has been and is still being done by the Government Entomologist (Dr. Ripley) at the Cedara Agricultural Laboratory near Maritzburg. Craib [1] states that "Between October and February it may cause the partial or complete defoliation of wattle stands of all ages." Dusting by aeroplane with natural cryolite has been successful in recent years in checking the annual ravages of this pest. The success of this dusting depends on catching the newly hatched bagworm at just the right stage and on the weather at the time of dusting. Rain immediately after the operation will spoil the results. From what I could learn, 10/- to 15/- per acre seems to be about the cost of aeroplane dusting, provided 100 acres or more are done.

(*b*) *Froghopper* is not as serious a pest as bagworm in South Africa, but nevertheless the annual damage is estimated at over £30,000.

Stephens and Goldschmidt [3] describe the damage as follows: "The first sign of attack is the curling of the leaves at the tips of the branches and the leading shoot. In severe attacks leaflet shedding and often complete defoliation follows. . . . On the uppermost branches and the leading shoot the resultant effect is that of a witch's broom, for they are the shoots which are most severely attacked." The damage causes loss of growth and deformity of stem in the trees attacked. Whole plantations are affected.

Hand dusting of wattle plantations up to 12 feet in height to check froghoppers is now being tried out on one or two estates. A pyrethrum-talc mixture is used; it is sprayed over the trees by a portable duster, of which several patterns are on the market. The Forest Department at Maritzburg recommends the Root hand gun (Model C3), made by the Root Manufacturing Co. (1051 Power Avenue, Cleveland, Ohio, U.S.A.). Messrs. Mitchell Cotts and Co. are the agents in South and East Africa. I saw one of these dusters in the showrooms of Orchard Suppliers Ltd. (Agricultural Department of Mitchell Cotts) in Port Elizabeth. It is quite light (12 lb. empty), easy to work, and could be used with native labour (as in Natal). It costs about £5.

In South Africa a pyrethrum powder sold as Dry Pyrocide has so far been the most successful against froghopper. Experimental work is now in progress "to determine what insect powders are best for diluting the pyrocide, what degree of dilution is permissible, and what amount of dust must be applied to the foliage to kill the insects." [6]

Ripley [6] at present recommends a dilution of one part pyrocide to ten parts talc. This ready-mixed powder was being supplied to Natal growers by Robertsons Ltd., Cato Creek, Durban.

The Forest Research Officer at Maritzburg recommends an application of about 5 lb. per acre on small trees (under 5 feet in height); on trees 6 to 12 feet in height 8 to 10 lb. per acre will probably be needed. Cost per acre in Natal is 5/- to 6/- per acre, most of which is the cost of the powder. Dry Pyrocide (which purports to be "concentrated stabilized pyrethrum dust") is imported from the U.S.A. and costs 5/- per lb. in South Africa. A native can dust 3 to 4 acres of small trees in one day.

Froghopper has several broods in a season. For control to be effective dusting should be done on the first brood. The damage on wattle foliage due to froghopper does not become obvious until the second or third brood is active; after the damage begins to show on the trees therefore it is too late to dust. In Natal the froghopper appears generally in the early summer (November) with the advent of the rainy season. From this time young plantations are examined weekly for signs of insects. Ripley [6] states: "This is best done by the use of a net made out of a stout wire ring and a small pillow case. The rim of the net is held against one's hip and the ends of the branches sharply struck against the thigh inside the net, to dislodge the insects. A fair idea of their abundance can be quickly obtained by this method. Dusting should be done as soon as the insects become numerous and wherever they are abundant, and preferably before any of them reach the adult (winged) stage, because the young insects are killed much more easily than the adults."

Further information on froghopper in wattle is contained in two articles in the monthly publication *Farming in South Africa*. [5]

(*c*) *Other pests and diseases* of wattle are described in a recent paper by Stephens and

Goldschmidt [3]. They include gummosis and Albert Falls disease, both of which cause considerable loss in Natal plantations.

Gummosis shows up in the plantation as black stains near the base of the tree, extending sometimes several feet up the bole, accompanied by an exudation of gum. The affected trees are generally evenly distributed throughout the plantation and do not occur in groups. Even when the tree is not killed outright, its bark value is decreased and growth retarded.

Albert Falls disease is so called because it was on two estates in that district of Natal that the disease was first recorded. The foliage withers and within a few days the tree is dead.[1] Trees commonly die off in groups, and it is often the most vigorous trees that suffer.

The South African Government have obtained the services of Dr. Ledeboer to undertake research into wattle pathology, with special reference to its bearing on the diseases common in Natal plantations.

Bark grading

Dry wattle bark is exported as either chopped and pressed bark or ground bark. It is packed in metal-strapped hessian bales, each one containing 200 lb. of bark.

Government inspection of all bark intended for export is compulsory. The power to do this is vested in the Governor General by the Forest Act (1913) or its amendments (1917 and 1930). The conditions of inspection of wattle bark for export were proclaimed by Government in the Gazette [4] on 6th November, 1936. They include—

(1) Grading, examining and branding by the Government grader.
(2) Registration of every exporter and his brand.
(3) Submission by the exporter to Government of samples of each grade of bark that he intends to ship.
(4) Definitions of standard grades to which all exported bark must conform.

The three standard grades are called Prime, Average, and Merchantable. The definitions of standards are given separately for chopped and ground bark. They are as follows:—

"(*a*) *Chopped Bark*

Prime.—Extra heavy or thick well-dried mature bark of good external appearance and light colour on fracture. (*N.B.*—The term 'good external appearance' implies good colour, absence of undue amount of corkiness and absence of mould, mildew and/or other fungus disease.)

Average.—Well-dried mature bark of average thickness, colour and homogeneity. (*N.B.*—Homogeneity precludes the mixing of extremes of thickness and/or colour.)

Merchantable.—Well-dried thin bark of good colour and other well-dried bark of colour below average.

(*b*) *Ground Bark*

Prime.—Well-shredded well-dried bark of light colour, good weight and even texture.

Average.—Well-shredded well-dried bark of even texture and average colour.

Merchantable.—Well-shredded well-dried thin bark of good colour, and well-shredded bark of colour below average."

"Merchantable" is purely a utility grade; it is essentially a mixture of thin bark of good colour with thicker bark of poor colour. A homogeneous sample of thick bark of poor colour is debarred from export. The reason for this is plain. A sample such as this, containing a high percentage of tannin (but of colour below average) would be eagerly sought in certain overseas markets where the colour of the leather produced is not important, and the value of the Prime grade would inevitably suffer were a homogeneous sample of such bark allowed in the Merchantable grade.

Method of bark grading and examination

Bark examination at Durban and elsewhere is entirely in the hands of the Forest Department. When standard grades were first introduced in 1936 a Divisional Forest Officer was appointed to the post of Government Bark Grader. He learnt the job as he went along. He has now established the standard of the grades, and has achieved such a degree of accuracy in his handling and assessing of samples that chemical analysis, which is used as a periodical check on his standards, invariably is found to confirm his grading. He now has an assistant, also seconded from the overseas-trained technical staff of the Forestry Department.

Grading is not centralized; the grader visits the factories or yards from where the bales are exported, and examines each consignment on the spot. This entails some travelling, not only in Durban but also inland.

[1] The cause of this disease is still unknown. Cf. "Sudden Death" of cloves in Zanzibar, which it resembles in certain respects.—*Ed.*

For inspection, 70 per cent of the square root of the total number of bales in the consignment are selected and set aside for sampling. Of these, 10 per cent are broken out and emptied for more detailed examination. After this examination the broken-out bales are returned to the exporter's stock, but the sampled bales are closed up and included in the consignment under inspection.

For sampling, a handful of bark is extracted from each bale; the samples are laid out in adjacent heaps on a table or tarpaulin; each sample is examined (by feel, appearance, smell, and even taste), and marks given to each sample according to the graders' assessment for weight (thickness), colour, and moisture content. A simple mathematical system of equalization is used to correlate the values of the three factors for all samples, and so establish the grade of the consignment. All hand samples are then mixed on the table and examined as a whole to confirm the results of the individual examinations. These are again checked by the examination of the broken-out bags.

When the assessment is completed the grader authorizes the stencilling of the appropriate grade mark on the bags, and he is present while this is being done. He later hands the representative of the exporters a certificate of grading for the consignment.

Bark prices

The following were the prices being paid for bark in November, 1939, by the manufacturers to the growers. All prices are for bark delivered in Durban; bark prices at factories inland are Durban prices less cost of railage from factory to coast:—

Green bark—	
Prime	£3 5 0 per ton
Average	£2 17 6 per ton
Merchantable ..	£2 10 0 per ton
Stick bark—	
Prime	£6 15 0 per ton
Average	£6 0 0 per ton
Merchantable ..	£5 5 0 per ton

Railway freight on bark and extract for export

Cut or chopped bark in lots of 10 tons or over costs up to about 12/- a ton, e.g. Maritzburg to Durban, 71 miles, 6/- per ton; Piet Retief to Durban, 378 miles, 12/4d. per ton.

Extract is charged for at the same rate in lots of 10 tons or over.

FUMIGATION OF COFFEE SEED

Experiments to determine the influence of the concentration of carbon bisulphide (100 to 400 cc/m³) on the germination of coffee seeds, without impairing its germinative power were made. Time and concentration of carbon bisulphide entered as variables in the experiments. It was found that when coffee seeds are fumigated during different lengths of time (3 to 24 hours) the maximum quantities of carbon bisulphide which may be used are those presented below:—

CS_2 cc/m³ ..	100	150	200	250	300	350	400
Fumigation hours ..	24	18	15	15	9	6	3

From the data contained in the above table, coffee seeds which are to be used for planting, cannot be submitted to the treatment recommended for the control of the coffee berry borer *Stephanoderes hampei* (Ferr.) (300 cc/m³ per 24 hours).

Luiz O. T. Mendes and Coaracy M. Franco, Revista do Instituto de Café do Estado de S. Paulo, Vol. 14, No. 152, p. 1028, 1939.

SEEDLINGS IN TRANSIT

Science Service, of Washington, D.C., reports the extensive use of a new and simple method of protecting young seedlings of tomato and cabbage from drying out during transit, which may have considerable importance in Great Britain at the present time. Dr. R. N. Du Puis, of Chicago, suggested that the plants might survive better if the sphagnum in which the roots were wrapped were moistened with a glycerine solution instead of with water. After encouraging large-scale experiments in 1939, the method was brought into commercial use, more than 75 million seedlings being shipped from the south to the north under these conditions. The new method apparently saved much loss from drying out and is also stated to give protection against fungus troubles.

Nature, Vol. 145, No. 3667, p. 219, 1940.

EAST AFRICAN PLANTS OF PROVED OR POTENTIAL VALUE AS DRUG PRODUCERS

By P. J. Greenway, Systematic Botanist, East African Agricultural Research Station, Amani, Tanganyika Territory

(*Received for publication* 28*th June,* 1940)

This list, arranged by the pharmaceutical names of the different drugs used in pharmacopœias, includes in an alphabetical sequence: (1) those species of drug plants native to or already introduced to East Africa; (2) those other East African plants which by reason of their botanical relationship might be expected on investigation to prove acceptable substitute sources for drugs normally derived from other species. Those species in parenthesis are neither indigenous nor cultivated in East Africa, but have been included because they have African botanical affinities of potential use.

As a rule under each plant an indication is given of the part of the plant used, the active principle and the use as quoted in *The British Pharmaceutical Codex,* 1934, *Potter's Cyclopædia of Botanical Drugs and Preparations,* 4th Edit. 1932, or *The Pharmacopœia of the United States of America,* 10th Dec. Rev. 1926. These three works are indicated by the initials (B) (P) (U) respectively. If none of these indications is used there is no pharmaceutical information about the plant under discussion.

When a plant has already been designated in the British Pharmaceutical Codex as a substitute source of a drug that plant is listed under the heading of the drug and the entry begins with the word "substitute". Where the plant has been reported as used medicinally by East African natives, this is indicated by "N.U.", with the addition of any specific native use that seems likely to be related to the pharmaceutical potentialities of the plant. It will be understood that, apart from those mentioned in this list, an immense number of plants are in native East African medicinal use; but their efficacy and their active principles remain a subject for critical investigation.

Geographical range is indicated as follows: Abys. = Abyssinia, Afr. = Africa, E. Afr. = East Africa, Ken. = Kenya, N. Rhod. = Northern Rhodesia, Nyas. = Nyasaland, Somal. = Somaliland, Tang. = Tanganyika, Trop. = Tropical, Ugan. = Uganda, Zanz. = Zanzibar.

ABRUS

Abrus precatorius L. Papilionaceae.
Seeds; abrin; ophthalmic diseases (B) (P). N.U. numerous, including that of an arrow poison. A climber widespread throughout E. Afr.

Abrus Schimperi Hochst.
N.U. A shrub, Abys. to Tang.

ABSINTHIUM

[*Artemisia Absinthium* L. Compositae.
Dried leaves and flowering tops; a volatile oil, glycoside, bitter principle; brain stimulant, tonic, stomachic, febrifuge and anthelmintic (B) (P). N. Asia, Europe and U.S.A.]

[*A. vulgaris* L.
Substitute (B). N. Temperate Regions.]

Santonica

[*Artemisia cina* Berg.
The dried unexpanded flower heads; santonin; a vermifuge for ascarides (B). Turkestan.]

[*A. brevifolia* Wall.
Substitute (B). India.]

Artemisia afra Jacq.
N.U. emetic, anthelmintic and febrifuge; shrubby herb found on most of the mountainous regions of Ugan., Ken. and Tang.

ACALYPHA

Acalypha indica L. Euphorbiaceae.
Whole plant; alkaloid; gastro-intestinal irritant, expectorant and emetic (B). N.U. An annual herb, a very local weed in cultivated land in Ken. and Tang., not yet recorded from Nyas. or N. Rhod.

Acalypha paniculata Miq.
Substitute (B). N.U. including roots as emetic. A widespread shrubby herb in fairly high rainfall regions throughout Trop. Afr.

ADHATODA

[*Adhatoda Vasica* Nees, Acanthaceae.
Leaves; vasicine, adhatodic acid, etc.; anti-spasmodic, expectorant, and febrifuge (B) (P). India.]

Adhatoda spp.
Several recorded from E. Afr. have not been chemically investigated; N.U. roots of *A. Engleriana* (Lindau) C.B.Cl. as purgative; Tang. and Ken., common in the W. Usambaras and on Kilimanjaro.

ADRUE

Cyperus articulatus L. Cyperaceae.
Roots; bitter; anti-emetic, sedative (P). Perennial, cosmopolitan in the tropics and sub-tropics.

AGROPYRUM

[*Agropyrum repens* Beauv. Gramineae.
Rhizomes; triticin, dextrose, mucilage, etc.; diuretic, demulcent, aperient (B) (P). Europe, N. Asia, Australia, America.]

Cynodon Dactylon Pers. Gramineae.
Substitute (B) (P). Perennial, locally common and often dominant in E. Afr.

ALOE

Aloe spp. Liliaceae.
The solid residue obtained by evaporating the liquid from the cut leaves; glycoside, barbaloin, resin, aloe-emodin and water-soluble substances of which nothing definite is known; cathartic, emmenagogue, and anthelmintic (B) (P). N.U., many species in E. Afr.

ALSTONIA

[*Alstonia scholaris* R. Br. and *A. constricta* F. Muell. Apocynaceae.
Bark; alkaloids, ditamine, echitenine, echitamidene and echitamine; a remedy for chronic diarrhoea, a febrifuge and tonic (B) (P). India, Burma, and the Philippines; Australia.]

Alstonia congensis Engl.
Bark; echitamine, the most important alkaloids (B). N.U. numerous, includ- febrifuge; a tree, W. Afr. to Ugan.

ARECA

Areca Catechu L. Palmae.
Seeds; alkaloids; astringent, vermifuge (B) (P). N.U. masticatory. A palm cultivated in small numbers on the coast.

ARISTOLOCHIA

[*Aristolochia indica* L. Aristolochiaceae.
Stems; a bitter principle which may be alkaloidal; a volatile oil, probably contains borneol; also said to contain aristin, aristinic acid, resin, tannin and starch; used in India for its bitter properties. (B). India.]

Birthwort

[*Aristolochia longa* L.
Root; aromatic, stimulant; rheumatism and gout (P). Mediterranean.]

Serpentaria

[*Aristolochia reticulata* Nutt. and *A. Serpentaria* L.
Rhizome and roots; a volatile oil, tannin and a bitter principle, apparently an alkaloid; stimulant, diaphoretic, anodyne, anti-spasmodic, tonic, nervine and a valuable remedy in all cases of fever. (B) (P) (U). U.S.A.]

Aristolochia spp.
About eight species recorded in E. Afr.; one, *A. densivenia* Engl., known to be very poisonous to man and stock. N.U., one, together with *Adenia gummifera* as an antidote to arrow poison.

ASPARAGUS

Asparagus officinalis L. Liliaceae.
Diuretic, laxative, cardiac and sedative (P). N. Temperate Regions.

Asparagus spp.
Numerous species in E. Af., N.U. numerous, including the treatment of Schistosomiasis.

ASPIDIUM (*see* "Filix Mas")

BELLADONNAE FOLIUM

[*Atropha Belladonna* L. Solanaceae.
Dried leaves and tops; the alkaloid hyoscyamine and possibly atropine; narcotic, diuretic, sedative and mydriatic, an anodyne in febrile conditions. etc. (B) (P) (U). Central and S. Europe.]

Phytolacca decandra L. and other species. Phytolaccaceae.
Substitute (B).

P. dodecandra L'Herit.
Contains a toxic saponin; said to be poisonous to stock. N.U. including anthelmintic and abortificiant. Shrub or liane, Trop. Afr.

BIRTHWORT (*see* "Aristolochia").

CALOTROPIS

Calotropis procera R. Br. Asclepiadaceae.
Bark; a bitter resin, an acid resin, a crystalline substance (madaralban), a viscid substance (madarfluavil), and caoutchouc; a diaphoretic and expectorant, a local remedy in India for elephantiasis, leprosy, chronic eczema, diarrhoea and dysentery (B) (P). N.U., numerous, including an arrow poison. Shrub or small tree throughout Trop. Afr., usually near native habitations.

CALUMBA

Jateorhiza palmata (Lam.) Miers. Menispermaceae.
Root; alkaloids; tonic and febrifuge (B) (P) (U). A liane indigenous to E. Afr. from Mombasa to Portuguese East Afr. Root mainly exported from Lindi in Tang.

CAMPHORA

Cinnamomum Camphora Nees & Eberm. Lauraceae.

Wood; a crystalline ketonic substance; sedative anodyne, anti-spasmodic, diaphoretic, anthelmintic (B) (P) (U). Trial plots established in Tang.

CANNABIS

Cannabis sativa L. (*C. indica* Lamk.). Cannabinaceae.

Dried flowering and fruiting tops of the pistillate plant; cannabinone; an anodyne, hypnotic and anti-spasmodic (B) (P) (U). N.U. narcotic; herb throughout Trop. Afr., often as a weed in native cultivations in E. Afr.

CAPSICUM

Capsicum minimum Roxb., *C. frutescens* L., and *C. annum* L. Solanaceae.

Fruits; capsaicin; stimulant, tonic, carminative, and rubefacient (B) (P) (U). Cultivated shrubs throughout Trop. Afr.

CARDAMOMUM, CARDAMOMI SEMEN

Elettaria Cardamomum Maton. Zingiberaceae.

Seeds; a volatile oil; carminative, stomachic (B) (P) (U). Cultivated in Tang. and Zanz.

CARUM

Carum Carvi L. Umbelliferae.

Fruits; volatile oil; carminative, stimulant (B) (P) (U). Central and Northern Europe a cultivated biennial herb, sometimes found in E. Afr.

CARYOPHYLLUM, CLOVE

Eugenia aromatica (L.) Baill. (*E. caryophyllata* Thunb., *Caryophyllus aromaticus* L.). Myrtaceae.

Flower buds; a volatile oil, eugenol; stimulant, aromatic, carminative (B) (P) (U). Cultivated in Zanz.

CASHEW-NUT

Anacardium occidentale L. Anacardiaceae.

Bark; material fevers not yielding to quinine (P). N.U. includes an intoxicant. Naturalized and locally dominant on the E. Afr. coast.

CATHA

Catha edulis Forsk. Celastraceae.

Leaves; alkaloids; stimulant, narcotic (B). A small tree locally common in E. Afr.

CHENOPODIUM

Chenopodium ambrosioides L. var. *anthelminticum* A. Gray. Chenopodiaceae.

Fruits; a volatile oil; vermifuge (B) (P) (U). A widespread annual or perennial weed; there are several others which are common in E. Afr. and have some medicinal value to the native.

CINCHONA

Cinchona spp. Rubiaceae.

Bark; alkaloids; anti-periodic, febrifuge, tonic and astringent (B) (P) (U). Cultivated in Tang.

CINNAMOMUM

Cinnamomum zeylanicum Nees. Lauraceae.

Bark; a volatile oil; aromatic, astringent, stimulant, carminative (B) (P) (U). A tree naturalized in Zanz., Pemba, and planted in Tang.

COCA, COCAINA

Erythroxylum coca Lam. and *E. truxillense* Rusby. Erythroxylaceae.

Leaves; alkaloids; nerve stimulant and anodyne (B) (P) (U). Experimental plots of *Erythroxylum* were established in Tang. but are now abandoned as its cultivation is prohibited by Government.

CONDURANGO

[*Marsdenia Condurango* Nichols. Asclepiadaceae.

Bark; poisonous glycosides; alterative, stomachic and aromatic, used in cancer (B) (P). Ecuador.]

Marsdenia spissa S. Moore.

N.U., Ken. and Tang.

Marsdenia umbellifera K. Sch.

N.U., Tang.

CORIANDRUM

Coriandrum sativum L. Umbelliferae.

Fruits; a volatile oil; aromatic, stimulant, carminative (B) (P) (U). An annual indigenous in Europe, cultivated in E. Afr.

CUCURBITA

Cucurbita maxima Duch. Cucurbitaceae.

Seeds; a reddish fixed oil; taenicide (B). N.U. Widespread through E. Afr., usually cultivated.

CUSSO *or* KOUSSO

Brayera anthelmintica Kunth. Rosaceae.

The dried mature inflorescences; kosotoxin; an anthelmintic for tapeworm (B) (P). A tree indigenous from Abys. to S.W. Tang., usually on volcanic mountains.

DATURA FOLIUM, D. SEMEN

Datura Metel L., *D. innoxia* Mill. Solanaceae.

Leaves, flowering tops and seeds; hyoscine, a substitute for stramonium (B) (P). India. *D. Metel* common throughout E. Afr. N.U. narcotic, stimulant and poison.

Daturina

Datura Stramonium L. Solacaceae.
Plant; alkaloids; nerve stimulant, sedative and hypnotic (B). An annual introduced weed, local but widespread through E. Afr.

Stramonium

Datura Stramonium L. Solanaceae.
Leaves, flowering tops and seeds; alkaloids; anti-spasmodic, anodyne, and narcotic (B) (P) (U). An annual introduced weed, local, but widespread through E. Afr.

EMBELIA

[*Embelia Ribes* Burm. f. and *E. robusta* Roxb. Myrsinaceae.
Fruits; embelin or embelic acid, alkaloid; toenicide, carminative and diuretic (B) (P). India.]

Embelia kilimandscharica Gilg.
N.U., dried fruits and roots; anthelmintic, an overdose poisonous; N. Tang. in forest.

Maesa lanceolata Forsk. Myrsinaceae.
N.U., fruits and roots; anthelmintic; widespread on margins and clearings in evergreen forest in E. Afr.

Rapanea rhododendroides Miq. Myrsinaceae.
N.U., fruits; anthelmintic; Ken. and Tang. in forest.

R. usambarensis Gilg.
N.U., roots; aperient; W. Usambaras, Tang., in forest.

ERYTHROPHLOEUM

Erythrophloeum guineense G. Don. Caesalpiniaceae.
Bark; poisonous alkaloid; an anaesthetic in dentistry, astringent and laxative (B) (P). N.U., in W. Afr. an ordeal poison. Very locally common throughout Trop. Afr.

E. africanum (Welw. ex Benth.) Harms.
Poisonous alkaloids in the roots; N.U., gum. The leaves are recorded as being very poisonous to stock. C. and S. Tang., N. Rhod.

EUCALYPTUS

Eucalyptus globulus Labill. and other spp. Myrtaceae.
Leaves; a volatile oil, together with tannin; antiseptic, anti-spasmodic, stimulant (B) (P) (U). A number of species are cultivated in E. Afr.

EUPHORBIA

Euphorbia hirta L. Euphorbiaceae.
Whole plant; gallic acid, quercetin, a phenolic substance, an amorphous glycoside and a sugar; anti-asthmatic and pectoral (B). N.U., ophthalmic. A common annual weed in E. Afr.

EUPHORBIUM

[*Euphorbia resinifera* Berg. Euphorbiaceae.
Dried latex obtained by incisions in the stem; euphorbone; emetic and drastic purgative (B) (P). Morocco.]

Euphorbia Tirucalli L.
Contains much latex. N.U. emetic; common in dry areas in E. Afr. There are numerous other species of succulent *Euphorbia* in E. Afr.; many N.U.

FILIX MAS

[*Dryopteris Filix-mas* (L.) Schott. Polypodiaceae.
Rhizome and frond-bases; an oleoresin; anthelmintic (B) (P) (U). Europe and America.] This fern is not recorded in E. Afr. but the following are similarly used by the natives: *Cyathea usambarensis* Hiern, Cyatheaceae, *Marattia fraxinea* Smith, Marattiaceae, *Pteris dentata* Forsk., Polypodiaceae. The natives also state that a strong dose of either of the first two will cause blindness.

FOENUM-GRAECUM

Trigonella Foenum-graecum L. Papilionaceae.
Seeds; mucilage; emollient; also used in veterinary medicine (B) (P). Morocco and Bombay. An annual cultivated as a curry stuff in E. Afr.

GOSSYPII CORTEX

Gossypium spp. Malvaceae.
Root bar; acid resin; emmenagogue, parturient, oxytocic (B) (P). Cultivated in E. Afr. for its floss.

GRANATI FRUCTUS CORTEX and RADICIS CORTEX

Punica Granatum L. Punicaceae.
Root, root-bark and fruit; gallotannic acid, and several volatile alkaloids; astringent and taenifuge (B) (P) (U). Cultivated in the Mediterranean. N.U., anthelmintic; very local on E. Afr. coast, usually planted.

HAEMATOXYLUM

Haematoxylon campechianum L. Caesalpiniaceae.

Wood; a colourless crystalline body, haematoxylin; astringent (B) (P). Small tree, Central America and West Indies; experimental plots in Tang.

HOLARRHENA

[*Holarrhena antidysenterica* Wall. Apocynaceae.

Root and stem bark; alkaloids. conessine and others; amoebic dysentery (B). India.]

H. febrifuge Klotz.

Roots, root-bark and sap; N.U., including febrifuge and treatment of bilharzia. Locally common shrub or small tree on E. Afr. coast.

HYDROCOTYLE

Hydrocotyle asiatica L. (*Centella asiatica* (L.) Urban). Umbelliferae.

Plant; marked diuretic qualities, given in fevers, bowel complaints and for syphilitic and scrofulous conditions (P). N.U. A perennial weed in Trop. Afr.

HYOSCYAMUS

[*Hyoscyamus niger* L. Solanaceae.

Dried leaves and flowering tops; hyoscyamine, atropine and hyoscine; anodyne, narcotic, mydriatic (B) (P) (U). Biennial herb, Europe.]

H. muticus L.

Substitute (B); alkaloids, including hyoscyamine; nerve stimulant and sedative. Egypt. Recorded as wild in Ugan.

JAMBUL

Eugenia Jambolana Lamk. (*E. Cumini* Druce). Myrtaceae.

Seeds; starch and resin; astringent, diuretic and useful in diabetes (P). India and Malaya, naturalized and often dominant in places on E. Afr. coast.

KALADANA

Ipomoea hederacea Jacq. Convolvulaceae.

Seeds; a fixed oil and a resin; a powerful purgative (B). India. An annual climber rather local in E. Afr.

LAWSONIA

Lawsonia alba Lam. (*L. inermis* L.). Lythraceae.

Leaves and roots; fats, resin, acid and a colouring matter, lawson; astringent and a hair dye (B) (P). N.U., a common and sometimes dominant shrub in places on the E. Afr. coast.

LITMUS

Rocella tinctoria DC. and *R. Montagnei* DC. Rocellaceae.

Lichens; pigment; used as an analytical indicator (B) (P) (U). Found on trees down the E. Afr. coast.

MADDER

[*Rubia tinctorum* L. Rubiaceae.

Roots; dyestuff, reputed effectual in liver diseases and for promoting menstrual and urinary discharges (P).]

Rubia cordifolia L. and *R. conotricha* Gandoger.

N.U., a most important dye to several tribes, also medicinal; E. Afr.

MARANTA

Maranta arundinacea L. Marantaceae.

Rhizomes; starch; demulcent, non-irritating, nutritive (B) (P). West Indies. A perennial herb cultivated to a certain extent in E. Afr.

MATE

Ilex paraguayensis A. St. Hil. Aquifoliaceae.

Leaves; caffeine; stimulant and diuretic (B) (P). Brazil. Successfully established in Tang.

MATICA

Piper angustifolium Ruiz & Pav. Piperaceae.

Leaves; astringent, stimulant, diuretic, styptic (B) (P). South America. Successfully established in Tang.

MUCUNA

Mucuna pruriens DC. Papilionaceae.

The hairs covering the pods; anthelmintic, rubefacient (B) (P). N.U., roots as an anthelmintic. Widespread in E. Afr.

MYRICA

[*Myrica cerifera* L. Myricaceae.

Root-bark; volatile oil, starch, gum, albumin, tannic and gallic acids and resin; a powerful stimulant, astringent, tonic, emetic (B) (P). North America.]

Myrica spp.

In mountainous regions in E. Afr., the most common being *Myrica salicifolia* Hochst. ex A. Rich. N.U., including nerve stimulant and emetic.

MYRISTICA

Myristica fragrans Houtt. Myristicaceae.

Seeds; volatile oil, a solid fat, the fatty acids consisting mainly of myristic acid; carminative, stomachic (B) (P) (U). West Indies and Penang. N.U., mainly by women, probably as an emmenagogue. Successfully established in Tang. and Zanz.

NUX VOMICA

[*Strychnos Nux-Vomica* L. Loganiaceae. Seeds; alkaloids (strychnine, brucine, etc.); tonic, bitter, stimulant (B) (P) (U). India, Malay Archipelago.]

[*S. nux-blanda* Hill and *S. potatorum* L. Substitutes (B).]

S. procera Gilg & Busse.
Leaves, bark of the stem and branches have a strong bitter persistent taste, and are used by the natives for stomachic complaints. S. Tang. There are numerous other species in E. Afr., the fruits of many with edible pulp. N.U., nummerous, including snake-bite remedies.

OLEUM CAJUPUTI

Melaleuca Leucadendra L. Myrtaceae.
Leaves and twigs; oil, containing cineole; stimulant, anti-spasmodic, diaphoretic and carminative (B) (P) (U). East Indies to Northern Australia. Successfully established in Tang.

OLEUM CHAULMOOGRAE

[*Hydnocarpus Kurzii* (King) Warb. (*Taraktogenos Kurzii* King). Flacourtiaceae.
Seeds; a fixed oil; leprosy (B) (U). India. *See* "Oleum Hydnocarpi."

OLEUM CORIANDRI (*see* "Coriandrum")

OLEUM CROTONIS

Croton Tiglium L. Euphorbiaceae.
Seeds; a fixed oil; irritant, rubefacient, cathartic (B) (P) (U). Indigenous to Malabar; trial plots established in Tang.

OLEUM EUCALYPTI (*see* "Eucalyptus")

OLEUM HYDNOCARPI

Hydnocarpus Wightiana Blume. Flacourtiaceae.
Seeds; a fatty oil; has properties similar to chaulmoogra oil, and has almost entirely replaced it in the treatment of leprosy (B). India. Trial plantings of *Hydnocarpus anthelmintica, H. ilicifolia* and *H. Wightiana* have been made in E. Afr., the latter successfully in some places.

OLEUM MYRISTICAE (*see* "Myristica")

OLEUM RICINI (*see* "Ricini Semen")

OLEUM SANTALI

[*Santalum album* L. Santalaceae.
Wood; a viscid oil containing santalol; diuretic, antiseptic (B) (P) (U). India.]

Osyris abyssinica Hochst. Santalaceae.
N.U., diuretic and antiseptic. A tree widespread, usually in dry mountainous regions, throughout E. Afr.

O. tenuifolia Engl.
Has been used as a substitute for sandalwood; it appears to be confined to Kilimanjaro and the W. Usambaras in Tang.

OLEUM TIGLII (*see* "Oleum Crotonis")

ORCHILLA (*see* "Litmus")

OUABAINUM

Strophanthus gratus Franch. Apocynaceae. (*See under* "Strophanthus".)

Acocanthera Schimperi (DC.) Benth. Apocynaceae.
Wood; Ouabain or g-strophanthin, a glycoside used as a standard for the control of strophanthin preparations (B). Most of the chemical investigations on *Acocanthera* refer to *A. Schimperi* of Abys. and Eritrea, but some were probably done with material of other species, of which the following occur in E. Afr.:—

A. Frieseorum Mgf.
Usually on volcanic mountains, Abys. to Tang.

A. longiflora Stapf.
Usually on mountains, Somal. to Bagamoyo in Tang., appears to be most common in the W. Usambaras, Pares, Teita Hills and round Nairobi. Often planted as an ornamental shrub.

A. venenata G. Don var. *typica* Mgf.
Utschungwe Mtns. in S.W. Tang. *A. venenata* is typically S. Afr.

All are evergreen shrubs or small trees; one of the most important arrow poisons in E. Afr. is obtained from the stems, leaves and branches of these species, yet the fruits are edible.

PAPAINUM

Carica Papaya L. Caricaceae.
Juice of the unripe fruit; papain; digestive (B) (P). Cultivated in E. Afr.

PEPO

Cucurbita Pepo L. Cucurbitaceae.
Seeds; a fixed oil; taenicide, diuretic and demulcent (B) (P) (U). N.U. Widespread through E. Afr., usually cultivated.

PERSIO (*see* "Litmus")

PHYTOLACCA (*see* "Belladonnae Folium")

PIPER NIGRUM, P. ALBUM

Piper nigrum L. Piperaceae.
Fruits; alkaloid, piperine, and a volatile oil; carminative, stimulant (B) (P). Malaya, East Indies, etc. Successfully established in Tang.

QUININA (*see* "Cinchona")

RICINI SEMEN

Ricinus communis L. Euphorbiaceae.
Seeds; a fixed oil, glycerides of ricinoleic and other acids; cathartic, purgative (B) (P) (U). N.U., numerous, but chiefly externally for rheumatism. Shrub, widespread in cultivated and waste land.

SANTONICA (*see* "Absinthium")

SARSA, SARSAPARILLA

[*Smilax ornata* Lem. Smilacaceae.
Costa Rica.]

[*S. medica* Schlecht. & Cham.
Mexico. Roots; sarsasaponin, crystalline glycoside, etc.; an alterative, used at one time in the treatment of chronic rheumatism, skin diseases and syphilis (B) (P) (U).]

[*S. officinalis* H.B.K.
Substitute (B). Jamaica.]

S. Kraussiana Meisn.
Roots; N.U. numerous, including the treatment of venereal diseases and as anthelmintic. A perennial climber, widespread through Trop. Afr.

SCILLA

[*Urginea Scilla* Steinh. Liliaceae.
Bulbs; glycosides and bitter principles; diuretic, expectorant, cathartic and emetic (B) (P) (U). Mediterranean.]
Several species recorded from E. Afr., one, *U. altissima* (L.f.) Baker, known to be toxic to stock; another related to *U. sanguinea* Schinz, an arrow poison in Tang.

SENNA

Cassia acutifolia Del., *C. angustifolia* Vahl (*C. Senna* L.). Caesalpiniaceae.
Leaflets and pods; glycosides; laxative, cathartic (B) (P) (U). North Africa and India. Rare in Trop. Afr.

C. auriculata L.
Substitute (B). Naturalized Tang.

C. holosericea Fresn.
Substitute (B). Abys.

[*C. montana* Hayne.
Substitute (B). India.]

C. obovata Coll.
Substitute (B). Local, E. Afr.

The following recorded from E. Afr. are used by natives in stomachic complaints and as purgatives:—
Cassia absus L., *C. Aschrek* Forsk. (a violent purgative), *C. didymobotrya* Fresn. (a fish poison), *C. Petersiana* Bolle and *C. singueana* Del.

SERPENTARIA (*see* "Aristolochia")

SIEGESBECKIA

Siegesbeckia orientalis L. Compositae.
Whole plant; fluid extract; alterative, anti-syphilitic (P). A very local but often dominant weed in Tang. and Ken.

STRAMONIUM (*see* "Datura folium")

STROPHANTHINUM, STROPHANTHUS

Strophanthus Kombe Oliv. Apocynaceae.
Seeds; poisonous glycosides (K-strophanthin), a cardiac drug (B) (P) (U). N.U. arrow poison, S. Tang., Nyas and N. Rhod.

S. Courmonti Sacleux.
Substitute (B) (U). A locally common climber in Ken., Tang. and Nyas.

S. Emini Asch. & Pax.
Substitute (B). N.U., arrow poison. A scandent shrub or small tree in N.W., Cent. and S.W. Tang. and northern N. Rhod.

S. gratus Franch.
Substitute (B). Seeds; glycoside, ouabain also known as g-straphanthin. N.U., arrow poison.W. Afr.; was at one time in cultivation in Tang.

S. hispidus DC.
Substitute (B) (P) (U). A West African climber, recorded in Ugan. and successfully established in Tang.

S. Nicholsoni Holmse.
Substitute (B). A rare shrub, N. Rhod.

S. sarmentosus DC.
Substitute (B). N.U., arrow poison. W. Afr. and Ugan.

STRYCHNINA (*see* "Nux-vomica")

TAMARINDUS

Tamarindus indica L. Caesalpiniaceae.
Fruit pulp; tartaric acid, potassium acid tartrate and invert sugar; nutritive, refrigerant and laxative (B) (P), N.U., widespread in the drier parts of Trop. Afr.

TARAXACUM

Taraxacum officinale Wigg. Compositae. Roots and leaves; a bitter substance, taraxacin, choline, resin, etc.; diuretic, tonic, and slightly aperient (B) (P). A naturalized weed in the W. Usambaras, Tang., probably in Ken.

URGINEA

Urginea indica Kunth. Liliaceae. Bulbs; bitter principles similar to the glycosidal substances found in Scilla (B) (P). Local in E. Afr.

VISCUM

[*Viscum album* L. Loranthaceae. Leaves and stems; resin, viscin, inositol, ursone, etc.; nervine, anti-spasmodic, tonic and narcotic (B) (P). Europe.]

About fourteen species in E. Afr.; they are parasitic shrubs on trees.

ZINGIBER

Zingiber officinale Rosc. Zingiberaceae. Roots; volatile oil; stimulant, carminative and expectorant (B) (P) (U). Cultivated E. Afr.

EMPIRE DRUG CULTIVATION*

The memorandum on medicinal herb production recently issued by the Ministry of Health confined its observations to the four important drugs—belladonna, digitalis, hyoscyamus, and stramonium. It is not surprising that other authorities have taken up the matter at the point where the Ministry left off. An official body representative of the medical profession has recommended that, in addition to the four drugs which the Ministry of Health has taken under its care, the production of the following items of vegetable materia medica should be encouraged in Great Britain: anethum, caraway, chondrus (Irish moss), colchicum, Filix-mas, valerian, hamamelis, taraxacum, pyrethrum, psyllium, Datura tatula, fennel and liquorice; that the collection of seaweeds, as a source of iodine, should be undertaken on a large scale. The same official body also recommends that the production of the following drugs should be pursued within the British Empire: agar, bitter orange peel, benzoin, balsam of tolu, calumbra, camphor (natural and synthetic), cantharides, mirabilis, cascara sagrada, cinchona, chrysarobin, cocaine, creosote, derris, ephedrine (natural and synthetic), ergot, gentian, liquorice, hamamelis, Hyoscyamus muticus, ipecacuanha, jaborandi, krameria, lobelia, menthol (natural and synthetic), almond oil, star aniseed oil, oil of cade, oil of chenopodium, oil of lemon, oil of peppermint, turpentine and colophony, psyllium seeds, rhubarb (*Rheum raponticum*), santonin, squill, storax, thymol (natural and synthetic), and tragacanth.

[*Note.*—The above extract should be read in conjunction with the reference to the subject in the Foreword to this number and to Mr. Greenway's list of potential drug plants. It will be noted that of the items recommended for production in the Empire only calumba is native to East Africa, and it is in fact already exported (*see* this Journal, Vol. 3, p. 385). Cinchona and derris are, of course, already the subject of active interest in East Africa. It is rather surprising to see the latter included in the list, for the Empire is already the main source of world production and only a very small proportion of the whole output can be devoted to what would usually be reckoned as pharmaceutical purposes.

Of the other items of botanical origin, balsam of tolu, camphor, cocaine, ephedrine, Hyoscyamus muticus, jaborandi, menthol, almond oil, oil of chenopodium, oil of cade, psyllium seeds, squill and storax are known to have been established successfully in certain localities on quite a small scale, while existing local plantations would suffice for commercial production of two other of the desired drugs, bitter orange peel and oil of lemon. Apart from the foregoing, benzoin, chrysarobin, creosote, ipecacuanha, ergot, turpentine, colophony, rhubarb, thymol and tragacanth could probably be supplied from East Africa, either from local substitute plants or from plants against the establishment of which there is likely to be no climatic bar. In considering the possibility that East Africa might contribute to Empire drug supplies in the present emergency it is, however, necessary to bear in mind that the plants needed for bitter orange peel, balsam of tolu, camphor, cinchona, almond oil, oil of cade, oil of lemon, turpentine, colophony and storax are trees, and that production from new plantings would be correspondingly slow.

It may be added that the drug lobelia is derived from a North-East American species, and although the genus is well represented in East Africa there is so far no indication that any of the local species are of therapeutic value.—ED.]

* Extract from *Nature*, Vol. 146, p. 454, 1940.

NATIVE METHODS OF FOOD STORAGE IN TANGANYIKA

By W. Victor Harris, M.Sc., A.I.C.T.A., F.R.E.S., Entomologist, Department of Agriculture, Tanganyika Territory

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Within the three hundred and seventy thousand square miles of Tanganyika the native inhabitants live under a wide variety of climatic conditions, at elevations ranging from sea-level to seven thousand feet, and with average annual rainfalls of from ninety to nineteen inches. The staple foods vary accordingly. The people of the coastal plain live mainly on maize and cassava, with rice in the river deltas, and beans, gram and pigeon peas as legumes. In the interior, sorghum and maize are the main grains, except in the dry central area, where bulrush millet is grown, and in the highlands of the south-west where it is too cold for sorghums and maize is grown alone. When the Great Lakes are reached rice once more becomes of importance. Of the legumes, gram and groundnuts are general throughout the west and south; bambara groundnuts are grown in the dry central area, although this is not a crop exclusive to such conditions, being also grown to a large extent in Bukoba; while the larger beans are found near the coast and in the higher elevations. Eleusine is widely grown at higher elevations in the interior, but primarily for the manufacture of beer. Wheat is grown in limited mountainous areas, mainly in the Livingstone Mountains, overlooking Lake Nyasa. Sesame is cultivated on the coastal plain mainly in the south of the Territory.

The storage of foodstuffs to carry over from one year's harvest to the next is essential throughout the greater part of the Territory. In areas of low rainfall, such as the Central Province, storage to meet possible crop failures is also necessary. Exceptions to this custom of storage are to be found in the humid banana-growing areas of Mount Kilimanjaro, Bukoba, and Tukuyu, in the wide plains inhabited by the pastoral Masai, and among fishermen, wherever they are, whose foresight, so far as food supplies go, is limited to the next day's fishing.

The following are the main food crops stored by the Tanganyika natives:—

Grains	*Swahili*
Maize (*Zea mays*)	*Mhindi*
Sorghum (*Sorghum vulgare*)	*Mtama*
Bulrush millet (*Pennisetum typhoides*)	*Uwele*
Rice (*Oryza sativa*)	*Mpunga*

Legumes	
Cowpea (*Vigna unguiculata*)	*Kunde*
Bonavista bean (*Dolichos lablab*)	*Fiwi*
Haricot bean (*Phaseolus vulgaris*)	*Maharagwi*
Lima bean (*Phaseolus lunatus*)	*Maharagwi*
Green gram (*Phaseolus aureus*)	*Choroko*
Black gram (*Phaseolus mungo*)	*Choroko*
Pigeon pea (*Cajanus cajan*)	*Mbaazi*
Groundnut (*Arachis hypogea*)	*Karanga*
Bambara groundnut (*Voandzeia subterranea*)	*Njugu mawe*

Owing to the tendency for sweating to take place during storage of legumes, particularly if attacked by insect pests, greater emphasis has to be placed on ventilation than is the case with grains; also legumes are not generally stored in so great a bulk as the grains are. Thus the methods of storing these two groups of foods tend to differ in many ways.

The main troubles in food storage, providing the crop is initially well-dried and housed in weatherproof stores, are caused by insect pests and rodents. The more important insects are the rice weevil (*Calandra oryzae*), the grain moth (*Sitotroga cerealella*), and the pulse beetles of the genus *Bruchus*. Numerous other insects appear as secondary pests or when heating has taken place. Among the rodents the common house rat (*Rattus rattus*) is the most destructive. The giant rat (*Cricetomys gambianus*) and the field mouse (*Mastomys coucha*) are more seasonal and less general in occurrence, although during its periodical epidemics the latter is very destructive.

While hard and fast divisions are difficult to define, there are three main types of storage methods which can be distinguished, viz:—

(1) In the dwelling in a loft between ceiling and roof.

(2) In the dwelling, in specially constructed bins resting on the ground and frequently in a part of the hut set aside for the purpose.

(3) In various types of stores built separately from the dwelling.

The two factors influencing the choice of storage methods appear to be, firstly (and most importantly), the type of materials available, i.e. timber for building large huts, large *Brachystegia* trees to provide suitable bark for sewn bins, grasses and reeds suitable for weaving baskets, clays adapted to pot making,

cow-dung for plastering, etc.; and secondly, the cultural trends of the people concerned, i.e. round-hut builders or rectangular, such tendencies frequently persisting when tribes have moved into areas which have materials available for other types of construction.

(1) Storage in loft of dwelling

The hill people of the Uluguru, Usagara and Nguru mountains of the Eastern Province, and of the Usambara mountains in the Tanga Province, together with a number of related tribes in the surrounding plains, build circular huts of a sufficiently substantial type to support a second story for use as a food storage loft (Plate 1). Strong timber is necessary for the building of such huts, and this is available in the sub-tropical rain forest which covers the upper slopes of the mountains named. On the plains, poles are cut from the gallery forest along the river banks. These double-storied huts are usually from twelve to fifteen feet in diameter, and up to fifteen feet high at the centre pole. If the roof is carried down to about five feet from the ground and a second wall built to support it, a very large hut results with a veranda-like outer room to accommodate live stock. The ceiling is supported on strong poles resting in forked uprights in the wall, and some seven feet above ground level. Walls and ceiling are completed with interlacing flexible branches and mud. As the family cooking is done in the living room, the fires keep the loft dry and well smoked, thus providing an atmosphere unfavourable to insect pests and keeping the moisture content of the grains low. In these lofts the maize is stored in the shuck and the sorghum in heads tied in bundles. The system is very efficient, and the people are able to grow the heavier yielding, large-seeded, soft sorghums which are under other circumstances seriously damaged by storage pests.

The coastal Swahili and the tribes he has influenced build a rectangular hut of sun-dried brick or poles and mud which is strong enough to take a light ceiling of poles and maize stalks. A storage loft is thus obtained, but not as a rule so robust as that in the circular huts. These people, however, do not generally cook in the living hut, but in a separate outhouse, with the result that crops stored in the loft are not protected by the smoke and heat of the fires and insect damage is more serious. Harder and less prolific sorghums have to be grown under these circumstances.

The Kutu of Southern Morogoro have a type of storage which provides a link between the loft above a dwelling hut and the separate store. Their huts are rectangular and small. A light ceiling is constructed over rather less than half of the hut, over the bedroom in fact, providing only a small storage space. Additional storage is provided by building a rectangular platform about four feet above the ground on poles. This platform has walls some three feet high made of sorghum stems and a grass roof. The lower portion is entirely or partly walled in with mud between the poles and is used as a kitchen thus providing smoke and heat for the loft as in a circular hut and enabling the Kutu to utilize the less resistant but heavier-yielding sorghum varieties. The general appearance of the building is that of a half-sized hut supported on stilts.

(2) Storage in the dwelling at ground level

The Sukuma and Nyamwesi of the plains south of Lake Victoria and the Gogo of the arid Central Province store their crops within the dwelling in containers of widely differing construction. The Sukuma and Nyamwesi build circular huts generally without ceilings, the Gogo low, narrow, flat-roofed huts. The Gogo are very short of timber suitable for building roomy huts; much of Sukumaland is grass cultivation-steppe with little or no timber. Only the Nyamwesi have an abundance of timber available, but they prefer to follow the Sukuma methods. Some coastal tribes not using lofts in their huts store their crops inside in bins, no doubt discouraged from erecting separate stores by the prevalent coastal habit of predial larceny. Small quantities of foodstuffs, particularly legumes, are stored in small bins, baskets, and especially in almost spherical burnt-clay jars by many tribes, independently of their methods of storing bulk stocks. Town dwellers particularly favour jars for storage, one reason being that they can easily be made ratproof.

In the west, bins are commonly made from the bark of *Brachystegia* trees, which are both numerous and large in the dry woodland. The bark is stripped from the trees in large pieces, five to six feet in depth and as wide as the circumference of the particular tree. The corky outer layer is removed with axes, leaving the smooth inner layer, which when wet is pliable and can be sewn into the desired shape with thin strips of bark. Tight-fitting lids of bark

PLATE 1

Circular hut with second story for food storage; ceiling timbers projecting. Morogoro District.

PLATE 2

Types of bins for food storage within the dwelling. Mwanza District.

PLATE 3

A Zinza homestead after harvest, showing maize drying on racks, also beehive store for sorghum and legumes on poles. Mwanza District.

PLATE 4

Storage bin of plaited bamboo strip. Kilwa District.

PLATE 5

Outdoor storage bin of grass and mud; an elementary type found among the Zinza of Western Mwanza.

PLATE 6

A well-built grain store in the Ufipa District.

PLATE 7

Grain stores of sorghum stalks, with roof supported by extra poles. These stores last one year only. Tunduru District.

PLATE 8

Grain stores of bamboo on the Lake Nyasa shore. Note pole used as ladder beside each bin. Tukuyu District.

PLATE 9

Rice store of plaited bamboo at Mwaya, Tukuyu District.

NATIVE METHODS OF FOOD STORAGE IN TANGANYIKA

PLATE 10
Method of storing legumes, with addition of neck of gourd to stop rats climbing the pole. Mwanza District.

PLATE 11
Beehive-like storage bin of grass rope. Kilwa District.

PLATE 12
Maize drying in bundles in tree. Arusha District.

are usually made for the smaller bins. In other areas, reeds and the stems of the larger grasses are used to make bins. These are frequently plastered with cow dung or a mixture of earth and cow dung. The Sukuma of the open plains make efficient bins of finely woven grass, not unlike fine raffia basket work (Plate 2). In the Kilwa and Lindi areas of the coastal plain, bins commonly follow the old straw beehive type with a more or less domed top, closed except for quite a small opening. These beehive bins are made from coarse grass ropes (Plate 11), plaited bamboo strips, (Plate 4) or similar material.

A simple method of storage employed by the Nyamwesi for their maize, and among others by the rice-growing people of the Kilosa and Morogoro districts, is to cut off a portion of the hut with a screen of reeds or elephant grass, make a low platform of rough poles, twelve to eighteen inches from the floor, and heap the crop on this. Under these circumstances, the maize is left in the husk and the rice on the head as harvested. This method, while understandable in years of bumper crops, is not satisfactory for prolonged storage owing to the ease with which rodents can establish themselves. Hill rice is stored in the Uluguru mountains by heaping the heads of rice in small stacks on dried banana leaves; further leaves are worked in with the turned-up ends of the bottom layer, and these in turn are gathered in at the top and tied with rope, making a large packet.

Rush bags suspended from the roof of the hut are employed by the people of the Rufiji. This is a useful measure where flooding is an almost annual event, and bags up to six feet in length are met with. Among the Konde of the south-east, similar bags are made of plaited palm leaves and grass matting, particularly for the storage of sesame.

Legumes, particularly when required for seed, are commonly stored in bundles of grass, tied at both ends. This method prevents sweating, but does not otherwise reduce pulse beetle attack. Cowpeas, beans and gram are usually stored in small vessels after shelling, but large quantities, and also groundnuts and pigeon peas, are stored in bins without previous shelling.

(3) Storage in special structures

Generally speaking, the people to the south of the Central Railway and west of the Tabora–Mwanza Railway build separate grain stores specially for the purpose, and not connected with the dwelling. These represent a development of the larger indoor bins, mounted on a platform and protected from the weather by a thatched roof. Apart from restricted localities, as, for example, in Western Mwanza, where small straw beehive-like structures are made, coated with mud and without a separate thatched roof (Plate 5), the plan followed is one common throughout the greater part of tropical Africa and also in India. Where timber is available, strong poles are used to make a circular bin, which when plastered inside and out with mud is strong enough to support a thatched roof. Cross-members support a floor one or two feet from the ground. Such a grain store will last a number of years with only slight repairs to the mud walls and the thatch. Good examples of this type of store are found among the Hehe and Fipa of the southern and south-western highlands (Plate 6). In the south and south-east, long stout poles are less readily obtainable and the stores consist of a strong platform with a few long poles to support the roof, while the actual bin is constructed of sorghum or maize stalks, plaited branches or reeds, with or without mud filling (Plate 8). Much depends on the natural industry of the tribe as to whether or not their stores are decently built. The Nyakyusa of the rice-growing plains at the north end of Lake Nyasa make for their rice crop large stores of plaited bamboo resting on a strong platform and with an independently supported roof. Departure from the strictly cylindrical is often great when large bins are essayed (Plate 9). This general type of outdoor grain store occurs independently of the type of hut constructed by the tribe. An example of this is to be noted among the people of the southern Ufipa plateau, whose huts are small conical structures like American-Indian tents, made of mud and wattle, and well adapted to withstand the high winds, but who build good upright cylindrical grain stores.

The custom already referred to of storing legumes in grass bundles is carried a step further by the tribes along the southern shores of Lake Victoria. The bundle is made up around one end of a long pole, and well tied down with cord to make it weatherproof, then the pole is stood up in the compound outside. Out of reach of most animals, the bundle can be made absolutely ratproof by fixing the neck of a gourd over the pole just below the bundle (Plate 10).

The importance of thorough drying of the crop before storage is generally appreciated. Birds, baboons and fellow men often make it desirable that crops should not be left in the field once they are ripe, and so drying platforms are common, particularly in the south and west. They are usually from six to ten feet above ground, of rough poles, with walls about two feet high made of maize or sorghum stalks surrounding the platform. Here, maize in the husk or sorghum and rice in the head are allowed to dry, often until the approaching rains force the farmer to move his crops to shelter. Bumper crops may be left out, if necessary, by the simple addition of a grass roof to the platform, but this is not common practice.

Among the Sukuma and Nyamwesi, racks for maize drying are common. The maize cobs are tied together by the outer husks and then hung over horizontal poles supported on stronger uprights (Plate 3). Maize remains on these racks for from three to four months.

The coastal Zaramu, the Sambaa of the Usambara Mountains, the Arusha, and the Zinza of Western Mwanza and Biharamulo tie their maize cobs by the outer husks into large spherical bundles and hang them up in the highest trees in the vicinity of their dwellings (Plate 12). The harder varieties of grain store well under these conditions and remain reasonably free from insect damage. It is not, however, a method generally relied on for storage during the rains, and it only appears to be employed by people having alternative food supplies, such as root crops, fish, or, as in the case of mountain people, a second crop of maize in the year.

THE TRADE IN BUSH KNIVES (MATCHETS, CUTLASSES OR PANGAS)

Prior to the outbreak of war, Germany held about 40 per cent of the world's matchet trade, England had 35 per cent, and the remainder was in the hands of the United States. Yet England's share was the output of only two factories, of which one, established well over a century ago, exists for no other purpose and produces more than 90 per cent of the country's total output.

The bulk of the production has always been taken by Mexico, the West Indies and the countries of Central and South America. The Island of Cuba was a market lost to Germany during that country's big trade drive before the war, but other markets have been defended successfully.

An example of the matchet's indispensability in tropical countries is that of Nigeria, West Africa, where a population of about 19,000,000 uses about 2,400,000 annually, or one matchet to every eight men, women and children in the country. Hitherto Britain has supplied only some 120,000 of Nigeria's yearly requirements, the remainder having come from Germany. Nigeria is now naturally looking to Britain for these essential implements, but inquiries are also increasing from all parts of the world, and particularly from Colombia, South America.

The matchet maker who attempts to sell a design which is not traditional is courting bankruptcy. The natives who wield them will not tolerate the slightest change, and what suits one country will not suit another. Some blades are broad and flat, others are broad and curl up towards the end; some are narrow and flat, others flat with a curved tip, and some are exactly like swords. They are made in varying sizes to suit men of different height, and certain patterns are made in a proportion of one in every nine specially suited for left-handed men.

Some blades have thin furrows, known as "blood lines," running down them. This is a relic of the days when matchets had not yet evolved from sailors' cutlasses, used by boarding parties for hand-to-hand fighting. A Venezuelan worker is content with one "blood line" in his matchet, but the man in Jamaica insists upon three. In Trinidad the blades must be plain. Tastes in handles also vary, some being wooden, others made of leather, fibre or buffalo horn from India. Matchets for British Guiana are made with welded steel handles, and those for lands around the Amazon are bound with brass wire.

The steel used in every British matchet represents one-third of its selling price, and in a busy year the two matchet firms between them make some 2,520,000 of these implements upon which tropical agriculture so largely depends.

Extracted from *The British Trade Journal and Export World*, Vol. 78, No. 931, p. 86, 1940.

MUCK AND MAGIC

These animadversions are prompted partly by a booklet[1] that we have received for review, and partly by an article by Sir Albert Howard that appeared in *The Countryman* and was reprinted in the *East African Standard* of 11th October, 1940, together with a review, by Major E. S. Grogan, of a book entitled *An Agricultural Testament*, also by Sir Albert Howard.

Major Grogan writes that this book "is merry stuff, and should set the beehive humming." Well, then, let this bee hum.[2]

There would seem to be four main schools of thought on this subject of compost. Firstly there is the old-fashioned farmer (and an increasing number not so old-fashioned) who has always believed that "muck is the mother of money" but has not entirely accepted the doctrine of the virgin birth of money. Secondly, there is Sir Albert Howard and his disciples who, while making supernatural claims for the value of muck, eschew supernatural aid in manufacturing it. Thirdly, we have the authoress of the booklet sent us for review, though we fear that she is merely a backslider from the fourth school, that of the Anthroposophists.

Let us consider these four schools in somewhat greater detail, but in reverse order, beginning with the most esoteric, the Anthroposophists.

It is impossible in a few words to outline all the peculiar tenets applied by Anthroposophists to agriculture, but the main points appear to be as follows. All life, animal and vegetable, is dominated by "etheric formative forces". These forces are both cosmic and terrestrial, the former occurring in fire and air, the latter in earth and water. (These, it may be noted, are the four "elements" of the medieval alchemists.) They emanate from the stars, the soil, insects, and from a host of other things, and somehow or other become condensed in certain plants, from which it is possible to extract them provided the correct magical rites are known. These rites include such processes as tying the plants between the horns of a cow, and exposing them to the influence of their appropriate planet. Any land will grow excellent and disease-free crops if, but only if, treated with manure or compost produced on the land itself and activated by infinitesimal doses of these occult preparations. It is not permitted to compensate for produce removed from the land by adding any fertilizer, whether organic or artificial, brought in from outside, and pest control is prohibited. The character and temperament of the cultivator are of great importance, and all his operations must be done at the propitious phase of the moon.

Much of this mumbo-jumbo has been discarded by the authoress of *From Vegetable Waste to Fertile Soil*. There is no mention of astrology or cows' horns, and in fact the booklet starts with a reasonably sound and simple method of compost-making. If it began at page 13 (as it does) but finished at the top of page 18 instead of on page 64, there would be little to criticize except the price of 2s. 6d.

But it goes on to emphasize the necessity of "accelerating" the compost by the addition of certain herbal "essences" and honey in what can only be described as super-homœopathic doses. Thus three-quarters of a drop of six mixed "essences" and one-eighth drop[3] of honey is sufficient for a heap that will produce one ton of compost, and it is even stated that an excess will cause the compost to go bad.

The formulæ for these "essences" are not secret like those of the Anthroposophists, but are freely given, together with pseudo-scientific reasons for their efficiency. Thus camomile is one of the six "essences" because it contains potash, lime, phosphorus and sulphur. No doubt it does, for all plants contain them, but imagination boggles at the quantity of these substances that one-eighth of a drop of camomile juice can add to a ton of compost.

Compared with all this nonsense, Sir Albert Howard at first sight appears to be, as the Red

[1] *From Vegetable Waste to Fertile Soil* (*Quick Return Compost System*) by Maye E. Bruce, 64 pp.; Sh. 2/6d.; London, C. Arthur Pearson, Ltd.

[2] Since this was written, several bees have hummed in the *East African Standard*, which reprinted, on 25th October, an article from *The Countryman* containing the views of Dr. Popplebaum (one of the Queen Bees of Anthroposophy) and the criticisms of Sir John Russell, Sir Daniel Hall and Prof. R. C. Wood.

No doubt before this is printed buzzing will have been begun by Pyramid prophets and the Pluviolunatics. (We are not being rude—it means the rain-moon experts.)

[3] A drop is about one minim; the final concentration of all the "essences" (which are themselves largely composed of rain water) is therefore approximately 1 in 20 million parts of manure.

Queen said, as sensible as a dictionary. No one will question that, as (in Major Grogan's words) the Apostle of Humus, he has rendered invaluable service. But like so many apostles, he attributes very much more to his god than the god ever dreamt of attributing to itself. Let us examine just one or two of his exaggerated claims. He says that a healthy plant, grown on soil rich in humus and without artificial manures, will be practically free from diseases and pests, and therefore entom-, myc-, bacteri- and other -ologists, not to mention chemists and statisticians, can go on the dole.

Consider the silkworm, Sir Albert; it may not toil much, but it certainly spins, at least when fed on healthy vigorously growing mulberry leaves. Do you really believe that silkworms thrive best on sickly mulberry trees? Yet the silkworm is no less of a pest from the point of view of the mulberry bush than the cutworm is from the cultivator's. You say that the floor of the forest is to be regarded as the ideal factory of humus. How then comes it that the loss from insect pests of forest trees, in the U.S.A. alone, for the one year 1936 was estimated at $130,000,000?[4] Or that during the first quarter of the present century, millions of acres of the magnificent forests of American chestnut in the eastern United States were annihilated by the chestnut blight, a fungous disease introduced from Asia?[5]

Of course, Sir Albert is, as often, partly right. There are many insects that only attack seriously an undernourished or otherwise weakly plant. This is true of many wood-borers and some scale-insects. But there is an even greater number of pests that thrive in proportion to the vigour of their host plant—most, if not all, leaf-eating insects, and the sap-sucking plant bugs. In short, his main thesis is, in Major Grogan's words, that "a healthy plant, and consequentially healthy beast can only derive from a healthy home." But where is there any essential difference between the antestia and the aphis (which we happen not to want) and the silkworm and the sheep (which we do want)?

Again, Sir Albert states that artificial manures "supply nutrients for the green leaf only. They are therefore unbalanced." One is tempted to think that his knowledge of artificials begins and ends with nitrate of soda. For there is much truth in the saying, even though its expression may be somewhat unscientific, that "Nitrogen makes foliage, Phosphorus makes roots and seeds, Potash makes sugar and starch."

Lastly, what is the commonsense view? A soil rich in humus is less affected by drought, it is easier to prepare a good tilth and to keep it in "good heart," and it is less liable to erosion, than an equally fertile soil the fertility of which depends entirely on artificial manures. Apart from these very considerable benefits, farmyard manure and compost return as much of the crop as possible to the land; if this residue was wasted, a greater expenditure on artificials would be essential to maintain fertility. On the other hand, artificial manures make it possible to return to the land those elements of fertility removed from it by any particular crop.

But even though we agree that, on the whole, there is "nothing like muck" and that it is "the mother of money", it is no less true that exaggeration is often the father of reaction, and many a good cause has been hindered rather than helped by making extravagant claims for it.

We might briefly mention a fifth cult, that of the Hydroponicists. These assert that the best crops are grown not only without organic manures or compost but also without soil, in water to which the necessary salt solutions are added. Aquiculture (surely a better word than Hydroponics) is perfectly sound scientifically, and indeed is no new thing, but it seems unlikely that it could ever replace ordinary methods of agriculture, except perhaps for the production of fresh vegetables in large cities or at aeroplane stations in desert countries. A debate between an advocate of Hydroponics and an Anthroposophist should prove highly entertaining.

But perhaps we have entirely failed to grasp the inner meaning of Anthroposophical agriculture. That it aims at replacing science by magic is certain. It is no less certain that its adoption would result in a decline in production. It purports to have originated in Germany. But did it? Is it not more likely that its purpose is to undermine the agricultural economy of the hardworking and peace-loving German people, and that in reality it emanated from the perverted brain of Mr. Winston Churchill?

T.W.K.

[4] *Destructive and Useful Insects*, Metcalf and Flint, 1939.

[5] U.S.D.A., *Year Book of Agriculture*, 1927.

THE PROGRESS OF GRASSLAND RESEARCH IN EAST AFRICA

By D. C. Edwards, B.Sc., Senior Agricultural Officer (Pasture Research), Department of Agriculture, Kenya

(*Received for publication 12th November*, 1940)

Grassland research is one of the youngest branches of agricultural science. As a specialized line of investigation it has grown only within the past twenty years or so. Gradually during this period thought has moved in the civilized countries of the world towards an appreciation of the true significance of grassland in the varied activities of the agricultural industry. Small wonder that in East Africa, where development from the primitive conditions of undirected native occupation has, in many parts, been in progress for a scarcely longer period, the awakening has only recently become evident.

An enormous area of East Africa consists of natural grassland, and in the moister regions where the vegetation climax is closed forest, pasture must also be an essential link in the farming systems of the future if the already alarming tendency towards soil depletion is to be checked. It can justly be said therefore that in every part of East Africa pasture management should be the foundation of the agricultural industry.

What has already been done towards this objective has been largely a matter of the views of individual workers in the various countries, workers who have often been able to devote only a part of their time to the study of grassland, and as yet there has been no co-ordinated effort accepted and supported by the governments concerned. In the past two years, however, a change has been taking place and there is good reason now to believe that a realization of the proper significance of grassland will be accepted. Were it not for the unfortunate circumstances that the outbreak of war followed close upon the first steps in this development, we might now be well on the way towards a plan of co-ordinated research which would have far-reaching effects upon the whole development of East Africa. With a view to considering such a plan, a conference of workers interested in grassland from the various territories was held in August last at Nairobi. This conference was the result of a suggestion put forward by the Secretary of State for the Colonies.

The move towards a greater interest in grassland matters has been clearly reflected in the increased number of articles on the subject contributed to both local and overseas journals. It would appear that a stimulus was provided by the report of Dr. Pole-Evans on his visit to Kenya in 1938 [1], and judging by the evidence of increased interest in practically every territory, which has just culminated in the first East African Pasture Research Conference, the report has gone far to accomplish its main object of focusing attention upon the necessity for a new outlook upon this very important subject.

The local articles and reports give some indication of the work that is in progress in the various countries, and moreover show that a considerable amount of important investigation, which may form the basis of a comprehensive inter-territorial plan of research, has already been undertaken.

In Kenya, attention has been directed over the past ten years to three main lines of work. These are: survey of the vegetation in order to make a regional classification of the grasslands [2]; study of the reactions to management of the natural grassland types and the provision of pasture species for temporary leys as an essential factor in the development of mixed farming in the areas of better rainfall [3].

The first of these lines, that of survey, has been of a preliminary nature, within the facilities which have been available in Kenya. The main zones of vegetation with their grassland types have been recognized and mapped, but much detailed survey remains to be done. The second line of determining the reactions to management of the natural grassland types has so far been confined mainly to an investigation of the mountain forest vegetation, which includes the Kikuyu grass (*Pennisetum clandestinum*) zone. The regional stations which are necessary to the study of the other main zones have not been available, and it appeared appropriate first to deal with the most highly productive grassland of the country and that which is capable of greatest development [4]. Based on a study of the indigenous flora, considerable progress has been accomplished in the isolation of pasture plants for the establishment of grass in rotation with arable crops, which is the third of the main aims of the work. It may now be claimed that

grasses which are suited to the climatic conditions, and of which a seed supply can readily be built up, are available for all the areas of Kenya where grass–arable farming is a practical proposition, and the recent study of ecotypes or naturally occurring strains of such grasses as *Chloris gayana* and *Cynodon* spp. gives promise of increasing the areas over which they can be used effectively. The discovery of leguminous plants for sowing with the grasses has proved to be much more difficult, and although for some areas such plants are available, much further work in this direction is necessary. Even so, research on this subject is far ahead of the present practice in Kenya, and the results already obtained in regard to the grasses await a change of outlook in both European and native communities for their full application.

Under the high-rainfall conditions of the greater part of Uganda, agricultural as opposed to pastoral pursuits assume relatively greater importance, and development in recent years has been concerned largely with a very rapid increase in the production of such cash-crops as cotton. A major problem has become the necessity to devise a means of maintaining soil fertility and avoiding erosion under the ever-increasing pressure upon the land. The solution of this problem lies in the combination of cattle with arable crops, by means of the temporary grass ley. The requirements are much the same as those of development in the moister regions of Kenya, already discussed.

Work bearing upon this subject in Uganda has dealt with the relationship between the root system and soil structure, and has cast light upon the effect of grass on soil fertility. At Serere, experiments have been directed to finding the most suitable pasture plants for use in grass–arable rotations and also to the effect of preceding crops on the subsequent development of grazing land; while at Entebbe a study of the effect of grazing on natural pasture has been made, with special attention to methods of recording the herbage [5]. Ecological studies with particular reference to the indicator value of grasses have also been undertaken [6] [7].

The work in Tanganyika has followed similar lines to that of Kenya. It has consisted of survey of the main stock areas, investigation of the management of natural grassland types and the study of individual species with a view to the artificial establishment of pasture, with the addition of work on soil and water conservation under semi-arid conditions. Interesting accounts of the research in Tanganyika have been given in the Annual Reports of the Department of Veterinary Science and Animal Husbandry from 1933 onwards [8].

In the remaining territories of East Africa little work aimed directly at the solution of grassland problems appears to have been undertaken, but such investigations as the very thorough ecological survey carried out in Northern Rhodesia [9] over the past few years have a definite bearing upon the subject, and will provide information of fundamental importance to future grassland research.

Having considered very briefly what has been done, the question arises as to what should be the aims of this work and what progress has been made towards the accomplishment of these aims. Taking a broad view, the chief requirement of development in East Africa is that of adjustment in the mode of living of the primitive peoples to the changed conditions produced by the advent of Europeans. The increase of human and animal population resulting from the cessation of tribal warfare and the control of disease has outstripped progress towards an improved food supply, and the old methods of land management can meet the increased demand only at the expense of progressive soil deterioration. Further, with the development towards a higher standard of living, which has come in certain areas largely through the medium of cash-crop production, the land is called upon to produce more than the primitive requirements of food for the consumption of the local population. New methods of agriculture must be devised which, after meeting the increased demand, will safeguard the wealth of the soil.

The chief factor in this change must be the better use of grassland. Over the extensive drier regions both the numbers and the movement of stock must be controlled according to plans based upon a study of the reactions of the various types of natural grassland to management, while such age-old practices as the use of fire must be studied and adapted rather than condemned offhand. Where the moister climate has permitted a concentration of population, the cultivation of grass in rotation with arable crops must be the means by which the soil structure is restored and animals, which have often been divorced from the existing forms of agriculture, are brought to be an essential part of the farming practice. Thus pasture management lies at the very root of agricultural development in these territories.

The requirements of both the pastoral and of the agricultural areas must be approached

from a regional viewpoint. Before the problems involved can be clearly distinguished and research undertaken effectively to deal with them, a foundation of survey must be laid. This should aim first at broad classification of the vegetation on the basis of climate and then at more detailed grouping in relation to soils and the requirements of various forms of occupation. It will be evident that this is an essential basis not only for research on grassland but also for the whole co-ordinated plan of agricultural research of which East Africa is in need. Apart from the ecological survey conducted in Northern Rhodesia, the surveys which have so far been accomplished are of a preliminary nature and are exemplified by the Vegetation Map of Kenya recently published [2] and the Provisional Soil Map of East Africa [10]. The former was compiled primarily in an attempt to view the grassland problems as a whole in relation to the major zones of vegetation.

In regard to the reactions to management of the natural grassland types and to the provision of pasture species suitable for mixed farming development, progress has been made in Kenya, Tanganyika, and Uganda, but in order to deal with these two lines adequately regional stations based on the zones of vegetation are essential.

Great prominence has recently been given to the problem of soil erosion in East Africa, following intensive effort in the United States of America to combat the alarming devastation caused by land misuse in that country. It is unnecessary to stress the fact that soil erosion is a very real problem, not only in East Africa but over the greater part of the continent, although it is perhaps necessary to draw attention to the relationship which exists between grassland research and soil conservation. Too often the fundamental nature of this relationship appears to be ignored, or at least to escape full appreciation. It is now widely accepted that a grass cover is the best form of erosion control, but the knowledge which has yet to be acquired in order to maintain the vast grasslands of Africa, which are at present changing more or less rapidly, tends to be disregarded. Furthermore, the resting of cultivated land under grass, in addition to its function as a medium for concentrating animals, implies much more than merely holding the soil. It is assumed that soil fertility is regained, but little is yet known of the precise effect of grass upon the soil. In Uganda, attention has already been directed to the effect of the roots upon soil structure, and in Kenya recent observations in grass experiments have led to the view that soil depletion under arable crops may be due, not primarily to the exhaustion of chemical fertility, but to deterioration of soil structure. The immediate effect of continuous cultivation, which implies periods when roots are absent from the soil, appears to be loss of the capacity to retain water which, under the prevalent erratic rainfall in Kenya, rapidly becomes evident in the early stages of establishment of succeeding crops [11]. Although engineering methods of erosion control are a necessary expedient to prevent further removal of the surface soil in advanced cases, the only feasible means of restoring the soil structure on a large scale is the inclusion of grass in the plan of management.

If the agricultural development of East Africa is viewed from the basic standpoint of grass and its management, the desirability of a co-ordinated plan of research becomes evident. The first pasture research conference held in Nairobi recently may be regarded as one of the most important steps so far taken in this direction.

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PASSION FRUIT GROWING IN QUEENSLAND *

Readers who studied the New South Wales Farmers' Bulletin No. 169 may have thought that there was little more to be said on the cultivation of "passions," but Barnes and Wills have produced a masterly and eminently practical treatise for Queensland growers. On fundamentals, the two accounts are much in agreement, except that Queensland favours the horizontal trellis while New South Wales considers the vertical to be the more suitable.

In Queensland, where cultivation of the crop has developed into an industry of some importance, it extends from the humid coast area to the south-east where frosts are liable to occur. So adaptable is this plant that, although it grows to perfection in moist semi-tropics, it can withstand light frosts, but will, however, succumb to severe cold spells.

The vines flourish on a variety of soils, but some consideration should be given to the selection of a suitable site. An ideal aspect is one open to the morning sun backed by rising ground and protected from prevailing winds by natural timber. The land is well prepared to enable the young plants to get away, and preparation should be completed before the rains to facilitate absorption. A practice in some localities is to protect the young plants and to keep down weed growth by the use of a paper mulch. Three or four furrows are ploughed towards the centre, and, after the soil has been finely broken down, paper strips eighteen inches wide are laid down. Holes are punched through the paper and the plants, which are watered in, are set through them. The planting distances are similar to those used in Kenya, namely 8 to 10 feet between the rows and 15 to 16 feet between the plants.

Much space is devoted to the systems of trellising, of which a variety are in use. It is emphasized that whatever system is employed the aim must be to allow of unimpeded cultivation with implements and to admit sunshine and air to all aerial parts of the vines. The two main types of trellising used in commercial plantations are the vertical and the horizontal. The horizontal trellis of two wires six feet from the ground is considered the more suitable, and should be substantially constructed to bear the weight of vine and fruit without sagging. No. 8 galvanized wire is commonly used, but 10 to 12 gauge high-tension steel wire is now favoured. It is lighter, stronger and carries the weight with less sagging than does iron wire. The two horizontal wires are spread by a cross member of from nine to twenty-four inches, the wider spacing being recommended. Other systems consist of three or four horizontals.

The usual practice in cultivation is to keep the lateral growth cut back six inches from the ground, as fruit in contact with the ground is easily damaged and of little commercial value. This shortening removes a considerable proportion of productive vine. An ingenious device, known as an extension trellis, to enable full advantage to be taken of this growth is described and working drawings for its construction are given. It consists of two horizontal members, one on each side of the post, to which they are hinged by dowels about three inches below the permanent cross member. They project beyond this on either side for about two feet, thus allowing an extra two feet of vine on either side. Through the end of the extension piece runs the extra wire terminating on the straining posts. At the end of the extension piece is hinged a supporting arm, the other end of which engages with a notch lower down the post. After pruning, when no longer required, the supporting arm is released so that the extension member together with the extra wire hangs down alongside the post.

Seedling plants are removed from the nursery when about nine inches high; if grown beyond this stage, the top growth is cut back and the main roots severed. The plants are treated at the outset according to the system to be adopted. A few weeks after planting out numerous shoots appear from the base of the plant. When these are from 12 to 18 inches long, one, two or four of the most vigorous are selected and led by means of a light stake to the top of the wire. All other growth is cut away and side branches from the stem are suppressed, but leaves are allowed to remain to shade the stem and to aid development. If only one stem is left the tip is pinched out when the top of the wire is reached, and four branches near the top and as close together as possible are allowed to develop for training along the two wires in opposite directions. The "leaders" should be given long turns and be lightly tied at intervals. The laterals are encouraged to grow straight downwards and the leaders are stopped when they meet along the wires. If two stems are left, the tips are pinched out and two laterals allowed to grow

* H. Barnes and J. M. Wills, *Queensland Agricultural Journal*, Vol. 53, pp. 55-85, Jan., 1940.

from each. If four stems are left they are merely trained, two in each direction along the wires.

Vertical trellis consists usually of two or three wires one above the other and spaced about fifteen inches. For training on this system, if only one stem is left, it is stopped on reaching the bottom wire. Three or four laterals are selected near the top, two are trained in opposite directions along the bottom wire, and the other one or two carried up to the top wire. If only one is carried on, the tip is again pinched out and two branches trained in opposite directions along the top wire. With two main stems, the tip of one is pinched out on reaching the bottom wire, while the second is carried on to the top wire. With four main stems, two are trained in opposite directions along each of the wires.

Other less frequently used systems consisting of four or six vertical wires, or even welded sheep fencing, are described and illustrated. In the case of the latter a number of leaders are spread out fanwise. Such modifications appear to offer no advantage and make subsequent management more difficult.

Cultivation is carefully carried out. It is pointed out that the passion fruit vine is a shallow-rooted, vigorous grower, and that much harm may be done by deep and careless cultivation when the crop is in full bearing. During the main growing period cultivation should be confined to weed control and the breaking up of the top inch or so of the surface soil. Deep cultivation should only be carried out after the vines have been pruned. In controlling the weeds it is advised to pull by hand when close to the base of the vine, in order to avoid injury. The crown should not be covered with soil and weed debris, but should be left exposed to lessen the likelihood of base rot, to which the passion vine is very susceptible. When rainfall is sufficient, a variety of green manure crops, such as cowpeas, peas, beans, lupins, barley, etc., are grown. The vine is a vigorous feeder, and on all but the most fertile soils will require a certain amount of artificial manure; 4 cwt. to 8 cwt. of the 10-6-10 mixture of ammonium sulphate, super-phosphate, and potassium sulphate per acre is considered suitable. No mention is made of the utilization of compost made of the waste from the factories or of the direct application of such waste to the land.

Few plants respond more readily to systematic pruning than the passion vine; not only is pruning necessary in order to stimulate the production of vigorous laterals and to a certain extent regulate the time of bearing, but also to keep growth, which would otherwise become a tangled mass, under control. This has an important bearing on disease control, as light and air must be admitted and all diseased leaves allowed to fall to the ground. It is recommended that the vines be heavily pruned once each year, but it is strongly emphasized that the vines should never be pruned during dry weather. Some growers prefer to give two light prunings, a practice which may commend itself to growers under Kenya conditions. It is pointed out that whatever system is adopted is dictated by local conditions. Heavy pruning consists of cutting back the laterals (droppers) to within two or three buds of the leader. Light pruning is done at any time, providing sufficient moisture is present, and consists of shortening the laterals to about half their length.

It is of interest to note that the useful life of a vine is put at only four years. Provision is made therefore for replacement by replanting every two years. This is usually done by planting young seedlings between the older vines. After cropping, every second vine is cut out and the new vines trained on the trellis to take their places. This method maintains a plantation at the optimum bearing age, but renders the control of disease more difficult, especially as regards "woodiness". A system of rotation is advocated which, although more expensive in that extra land and trellising are required, has the advantage that the plants do better, disease is more easily controlled, and the cultivation of the crop and maintenance of the trellis are more easily carried out. It is stressed, however, that with either method planting of young vines every two years is essential to maintain quality and yield.

Some notes on harvesting and packing, but less comprehensive than in the New South Wales Bulletin referred to above, are given, and pests and diseases are enumerated. For information on these, however, the reader is referred to other Queensland publications.

The article is a well-illustrated and informative exposition of the results of long experience in passion fruit growing, and is worthy of close study by Kenya growers, who will have no difficulty in seeing how far Queensland practice can be adapted to local conditions and also, incidentally, that passion fruit should be treated as an orchard rather than as a field crop.

R.M.N.

NUTRITION AND NATIVE AGRICULTURE IN EAST AFRICA

By A. T. and G. M. Culwick

(*Received for publication 11th October,* 1940)

General considerations

Dr. W. D. Raymond, in his paper "Minimum Dietary Standards for East African Natives," [1] sets out very clearly the minimum amounts of the more important food substances required to maintain Africans of both sexes and of various ages at different energy levels, and the object of this paper is to translate his biochemical conclusions into terms of peasant agriculture.[1] Grateful acknowledgment is made to Dr. Raymond for permission to make use of unpublished work.

A hardworking adult male African must have about 3,400 calories a day, the bulk of which will be derived from his staple, usually maize, sorghum, pennisetum, eleusine or rice. Weight for weight, there is little to choose between these foods as energy producers, and this may account for the fact that the encouragement of one or another of them has hitherto usually depended on considerations of yield, a very important point but by no means the whole story.

In African diets the staple plays a far more important role than that of a mere producer of energy. There are many areas where at certain seasons of the year it supplies 80 to 90 per cent of the protein intake, practically all the vitamin B_1, nearly all the nicotinic acid and important amounts of other essential substances such as vitamin A, calcium and phosphorus. It is obvious therefore that although the yield to be expected from a staple is very important, in that it determines the quantity of food available, chemical composition is equally important as a measure of its quality and properties. It is sheer waste of time making two ears grow where one grew before unless the two are more valuable than the one they replace.

Grains

Bearing these facts in mind, let us consider briefly the relative merits of the common grains.

Maize is a high yielder with low labour costs. There are many quick-growing varieties and also drought-resistant strains to be had. But maize is dangerous in that the white varieties—that is, almost all those grown in East Africa—are practically devoid of carotene, so that it is scarcely surprising to find vitamin A deficiency widespread among the maize-eating tribes where other foods containing vitamin A or its precursors are not extensively or regularly used. Maize is, moreover, very poor in calcium, and the biological value of its protein is low, viz. 60.

The most popular sorghums are longer maturing than maize and involve more labour, especially when it comes to scaring away the birds; but they are more drought-resistant, richer in calcium, and constitute an important source of carotene, while the biological value of their protein is said to be high, viz. 83. Pennisetum is dietetically on a par with the sorghums, and being still more drought-resistant it is a valuable crop for arid regions —sometimes the only possible one.

Eleusine is thought to be especially rich in calcium (0.2 per cent as compared with 0.007 per cent for maize[2]); it also contains carotene; it will grow on poor soils, and is quick maturing, but yields are poor and it needs ample water.

Rice, as everyone knows, requires special conditions. It is a tricky crop unless grown under well-controlled irrigation, but properly cultivated on suitable land it will yield more calories per acre than any other grain, and its protein is of high biological value, viz. 80. It is, however, very poor in carotene, and if highly milled loses most if not all of its vitamin B_1. The methods of storing, washing and cooking the grain are also important in respect of B_1. Long storage in sacks after hulling produces an unpleasant tasting product, needing very thorough washing before cooking, with a consequent serious loss of vitamin B_1. This is a point of importance as regards rice sold by traders, but the peasant himself normally stores it in the husk, hulling small quantities as required. Generally speaking, rice is a grain

[1] For the convenience of readers Dr. Raymond's summary of his conclusions is reprinted as an appendix to this paper.—*Ed.*

[2] Tanganyika varieties examined in the Dar es Salaam Chemical Laboratory.

which unless carefully handled is particularly liable to suffer depreciation of its nutritive value, and suitable methods of storing, processing and cooking it need to be investigated before natives give up, say, sorghum or maize and make rice their staple instead. More than one case of beri-beri has occurred among maize- and sorghum-eating natives who have gone over to rice without knowing how to treat it properly.

These facts lead one to the conclusion that the old popularity of the smaller grains (sorghum, pennisetum, eleusine) among the majority of the Bantu tribes of Africa had a sound empirical basis; and though in some areas maize or rice may produce more calories per acre, from the nutritional point of view one cannot but view with alarm sorghum-eating peoples deserting their well-tried staple in favour, for instance, of white maize, without making compensating changes in the rest of their diet.

Roots

For many years the agricultural departments of the East African territories have striven to increase the production of root crops, chiefly cassava and sweet potatoes; an insurance policy against famine following failure of the grain crop which has on many occasions proved its worth.

The sweet potato has always been considered vastly superior to cassava from the nutritional point of view. It contains about 40 per cent more protein, some vitamin B_1, a certain amount of the B_2 complex and appreciable quantities of vitamin C. The varieties commonly grown in East Africa do not contain any appreciable amounts of carotene.[1] As a crop, however, the sweet potato has its drawbacks. It is seasonal; the tubers must be lifted when mature or they will rot; and they are not particularly easy to store for any length of time. One method consists of splitting them and sun-drying them in ash. Another is to boil them, peel them, and compress them into thin cakes (*matabora*), which are then thoroughly dried in the sun. But this involves many hours of labour and, where a whole crop was concerned, would use a lot of fuel. In both methods the vitamin C is almost wholly lost.

In cassava, on the other hand, we have a longstanding crop which can be grown almost anywhere and which may, within limits, be dug for eating at any time over a long period. It is a heavy yielder, giving as much as eight tons to the acre; that is, rather more calories than maize would yield on an area three times as great. Except as a source of energy, however, it has hitherto been regarded by dieticians as a poor food, but Raymond has recently shown [2] that the fresh tubers contain appreciable amounts of vitamin C. This calls for revision of our opinion of cassava as a food crop and for its serious consideration as a supplementary source of vitamin C, especially during the dry season.

In recent work from a number of sources great stress has been laid on the toxic properties of cassava, some writers going so far as to talk of it as though it were a deadly poison. It is true that the roots of all varieties in the raw state contain cyanogenetic compounds, some more than others. In the so-called "sweet" types the toxic principles are said to be confined mainly to the rind, but in the "bitter" strains cyanogenetic glycosides are more uniformly distributed throughout the tuber. The two categories are not, however, distinct, but shade off into one another. Toxicity is not merely a question of variety; it depends also on environment. Indeed, it has been shown [3] that the same variety grown under different conditions may vary greatly in its hydrocyanic acid content, and that a "sweet" type may even change into a "bitter" one when given a different environment, thereby necessitating modification in its processing and cooking to render it safe for human consumption. In view of the alarmist reports current in nutritional circles, however, it cannot be too strongly stressed that when cassava is properly prepared it is perfectly safe; such danger as exists arises from the possibility of people unfamiliar with its preparation not carrying out the soaking and/or boiling necessary to remove the cyanogenetic glycosides from a "bitter" variety.

Summing up, we may say, first, that cassava constitutes an excellent famine reserve crop but that it is unsuitable as a staple by reason of its poorness in protein and vitamins A and B, except where alternative sources of these food substances are easily and regularly available. Secondly, cassava may prove a valuable supplementary source of vitamin C;

[1] The Tanganyika Agricultural Department is experimenting with varieties which do contain appreciable amounts of carotene. Recent analyses by Raymond give the following figures: Porto Rico Yam, 2234 micrograms carotene per 100 gms.; Makakunga, 250; Southern Queen, 240; Ashburn, 190; Zanzibar Caroline Lea, 500.

and thirdly, provided suitable methods of processing and cooking are used, it is a perfectly harmless article of diet.

Subsidiary foods

A widespread tendency to regard staples as simply interchangeable without reference to the equilibrium of the diet as a whole is greatly to be regretted, and the intimate relationship between the staple and the subsidiary foods deserves much more attention than it receives. It is often not fully realized that the kinds and amounts of subsidiary food crops the peasant should grow to maintain his health depend in large measure on the chemical composition of the staple. For example, a sorghum-eater who decides to switch over to white maize may very likely need to reorganize the planning of his subsidiary crops at the same time, because whereas his sorghum gave him important amounts of carotene his maize yields none, and furthermore, his sorghum provided protein of higher biological value than he will get from the maize. But who has ever told a native, "If you want to drop sorghum and plant maize instead, you should also grow more pawpaws, mangoes, peppers, groundnuts and beans, and you ought to keep a few more fowls and (in suitable areas) spend more of your time fishing"?

Assuming for the moment that we are dealing with a tribe whose staple is sorghum, the subsidiary food crops will be required to supply fat, protein, calcium, phosphorus, some vitamin A, vitamin C, and nicotinic acid, though a great deal of this last will probably be obtained in beer. If maize takes the place of sorghum, a proportionately greater amount of the required protein and vitamin A will have to come from the subsidiary foods.

Fats

The three chief sources of vegetable fat in East Africa are groundnuts, coco-nuts and sesame. The oil palm is also important, yielding the only vegetable oil of high vitamin A activity, but it is very difficult to get good germination of the seed even in the areas where the palm will grow well. Nevertheless, it could usefully be grown more extensively. The oyster nut (*Telfairea pedata*) is a source of vegetable oil which is very highly esteemed by the natives, especially for pregnant women, and this vine could easily be very much more widely grown in the villages than it now is.

Fats of animal origin are relatively little used by the native population at present, and their extended use is a problem both of supply and of purchasing power and the organization of produce exchange. On the supply side, the keeping of cattle is limited by tsetse-fly and their productivity is in any case a difficult problem (see below), while but little fat from other domestic animals is available. Where sheep can be and are kept, a little fat is from time to time consumed, derived from the fat tail. Goats can live fairly well over a much wider area than cattle or sheep, but we are unaware of any use of goats' milk by natives; and in any case the extensive keeping of goats is apt to be a doubtful blessing agronomically. Pig fat, apart from supply difficulties, need not in general be considered in a country where the influence of Moslem taboos affects a circle far greater than that of actual religious adherents. Fat from wild animals is a highly localized and very rare luxury.

Protein

Nutritional authorities are not yet agreed whether animal protein is or is not actually a necessity, but in the matter of protein from vegetable sources one fact is certain: It can only be utilized efficiently if those sources are sufficiently varied. Different proteins being complementary in their action, it is most desirable that the peasant cultivator should plant as many protein-producing crops as he can, to assure as varied and regular a supply as possible—groundnuts, beans and pulses, edible green leaves such as pumpkin, beans, sweet potato, taro, and so on. Ringing the changes on the staples helps too. The peasant can grow both maize and sorghum for his main dish; he could grow less rice (or sell more), and substitute sweet potatoes in his diet. He might even try a little eleusine too, if his environment permits its cultivation; it makes a good porridge and a beer which is greatly favoured by many tribes.

This question of variety opens up much larger questions of inter- and intra-tribal exchange, and they in turn lead to the fundamental psychological problem of stimulating in the population the necessary interest and the will to do all or any of this—a practical problem whose solution is a necessary condition of nutritional progress. These wide subjects cannot, however, be followed up here.

To return to the question of supply, even where everything possible has been done, it is still often not at all easy to ensure the regular provision of complementary vegetable proteins, and for this reason, if for no other, it is

desirable that animal protein in some form or other should be available to the peasant cultivator.

One naturally thinks at once of meat and milk, but it must be remembered that over vast areas the tsetse-fly banishes cattle. And a further point which is often overlooked or not realized is that, at the best of times, the production of meat and milk is a most inefficient process. "A thousand bushels of grain has at least five times as much food value and will support five times as many people as will the meat or milk that can be made from it." [4] At the same time, without supplementary feeding, cows in East Africa cannot be expected to yield worthwhile quantities of milk over and above what is necessary for the proper feeding of the calves, especially in the dry season; and it must be borne in mind that only about 4 per cent of the dry substances eaten by cattle will be converted into any form of human food. This explains why, even in cattle-owning tribes, the quantity of milk consumed per head of the population is usually very small and meat is in most of them regarded as a luxury. The manurial value of a cow is no doubt high enough to earn her a place in African agriculture irrespective of her utility as a direct producer of food; but as far as protein production is concerned what we really need is something not requiring acres and acres of pasture, large supplies of water, fertility and energy devoted to extensive production of supplementary feed instead of directly to the nourishment of man, something, moreover, not requiring a long period for maturing and reproduction, constant and vigilant herding—to furnish at the end of it all only a 4 per cent yield. And one of the answers, as the Chinese found out long ago, is poultry.

The hen and the duck can flourish on what to man (and often the cow) are inedible residues, and on insects, frogs, etc. They have that wonderful faculty of being able to discover the smallest morsel of food in the largest rubbish heap. Even when sorely neglected they will raise more offspring in a year than any cow could in a decade. They take up but little room, and in helping to keep down insect pests produce therefrom a palatable form of first-class protein. They are furthermore immune to trypanosomiasis, can be kept anywhere in East Africa, are extremely hardy and can stand transporting long distances even in the most unfavourable conditions. The chief item on the debit side is the heavy toll wild animals and (especially) hawks levy on them, but the former can be defeated by better chicken houses, preferably raised on poles, and the latter by planting trees or shrubs round the houses to give cover.

Unfortunately, the African takes advantage of the hardy hen. He knows she can keep herself alive without supplementary feeding and he lets her do it, the result being a light, tough bird and an extremely poor yield of small eggs. The hen is, however, an efficient converter and therefore for her it is well worth while organizing a supply of some form of supplementary feeding, at least during the dry season. In the rains, green food is plentiful, insects abound and poultry can often do quite well for themselves, but the dry season is a very different matter, a fact which the native must appreciate before we can hope to make his poultry more productive or to introduce better strains (whether pure or crossed) with any real measure of success.

Another valuable source of animal protein, and also of course of calcium, is fish, both fresh and dried. East Africa possesses many valuable fishing grounds, both on the coast and inland, which are capable of further development. Consumption appears to be restricted not by shortage of fish and certainly not by lack of demand on the part of the consumers, but rather by the great difficulty of distributing so perishable a commodity to a scattered population, which is extremely poor and cannot pay high prices for any article of diet. The whole question of the supply, preservation and distribution of fish is a complex subject needing careful investigation, which would, incidentally, have been carried out this year (1940) but for the war.

Another aspect of the question calling for study is the possibility of introducing fish culture into village life. Certain experiments in stocking lakes, streams and dams with fish have given very promising results, and where conditions are suitable, it should not be beyond the capacity of more intelligent natives to construct and stock village fishponds, a method of producing animal protein that has been eminently successful in other parts of the world. The sociological aspect of this subject requires elucidation as well as the technical, since questions of property, responsibility for maintenance and rights of use are involved, and need to be clearly understood by all parties.

On the technical side, those who wish to make further experiments should remember

that you cannot make fish from water—a fact obvious enough, but one which seems often to be overlooked—and that if you expect to take large amounts of nitrogen, calcium and phosphorus out of your pond in the form of fish, you must first see to it that those elements are there in adequate quantities. How this is done will depend on circumstances. The Chinese manure their fishponds with, among other things, human excreta, a method hardly to be commended as hygienic—though it does produce beautiful fish. But a little compost, household food residues, the weevilled sweepings of the grain store, or even some *boma* manure added to the pond from time to time will greatly increase its carrying capacity.

Fishponds needs not become breeding places for mosquitoes if one or more of the smaller kinds of fish which feed on larvae and eggs be introduced, provided of course that every part of the water surface is accessible to them. This fact has been proved in practice in a highly malarial district.

Minerals and vitamins

Besides carbohydrates, fat and protein, a well-balanced diet must contain adequate quantities of the subsidiary food substances, namely minerals such as calcium, phosphorus and iron, and vitamins.

Now the foods mentioned above as sources of carbohydrates, fats and proteins supply certain amounts of minerals, and vitamins too, but not as a rule in sufficient quantities, and for this reason it is essential to incorporate in the diet various subsidiary foods whose importance the African has, unfortunately, hardly begun to appreciate.

Green leaves are a valuable side dish eaten by most tribes, but usually only as a *pis aller*, though native ideas about green leaves are far from being fully known, e.g. it is probable that certain green leaves are eaten in special conditions such as pregnancy. The leaves of pumpkins, sweet potatoes, cassava, beans, cowpeas and of various wild plants, e.g. amaranths and *Gynandropsis gynandra* (*mgagani*), are used in season, supplying valuable amounts of calcium, iron, carotene and vitamin C. For example, cassava leaves [5]—in many places the most commonly used of all—contain in the raw state (per 100 gm.) 7 mgm. of iron, 0.2 gm. calcium, 0.13 gm. phosphorus, 8.2 gm. crude protein, of which 75 per cent is true protein of high feeding value. They also contain about 15,000 I.U. vitamin A (nearly all as B-carotene), 100 to 110 I.U. vitamin B_1, and 145 to 185 mgm. vitamin C. Toxic substances are present in the raw leaf, but these have been found by Van Veen to be entirely removed by cooking, and experiments now being conducted by Raymond have to date confirmed this finding. These leaves have further the advantage of being available for at least part of the season when others are scarce or unobtainable, but the practice of constantly removing the younger leaves is open to two objections from the agricultural point of view: it reduces the tuber yield and is thought to be instrumental in increasing the spread of virus diseases.

It is, however, of considerable importance, in view of the African's normally contemptuous attitude to green vegetables in general, that he finds cassava leaves exceptionally palatable; so much so that they are the only one he will not usually neglect in favour of meat or fish. On the contrary, he even considers them worth serving up at the same meal. This relative popularity, combined with their high nutritive value and the fact that owing to their acidity the vitamin C is apparently not destroyed even after long cooking (see below), makes it possible that they may have to be considered so valuable a foodstuff as to outweigh their disadvantages. In any case, the second agricultural objection presupposes the presence of virus disease ready to be transmitted and should not be insuperable, while the first could be met by growing some of the cassava primarily for leaf production and only secondarily for tubers.

The whole subject of leaf vegetables is at present in too fluid a state for any definite conclusions to be drawn or solutions proposed. It is impossible to do more than point out possible sources of supply, with some of the difficulties and advantages attaching to them, and to make tentative suggestions. It is not the sort of question to have one answer: there will be many answers of strictly localized validity.

On the supply side, in certain seasons there is no difficulty but in others the problem is not easy to solve. There are, as we have seen, certain objections to extensive use of that common native standby, cassava leaves. On the other hand, there is great difficulty about growing something to replace it. Apart from any technical difficulties which may exist locally, there is the fact that green leaves in general, other than cassava,[1] are merely something to be tolerated in the menu when other

[1] N.B.—The popularity of cassava leaves is relative. To some extent the remarks of this paragraph apply to them too.

more estimable side dishes are in short supply. Consequently the peasant rather naturally does not regard them as worth the trouble of cultivation; he merely accepts them as a by-product of agriculture, a dietetic increment incidental to the production of proper food. For this reason a suggestion, for instance, that a crop of cowpeas, planted too late to fruit, could in some places supply green leaves for much of the dry season would appear to the average African peasant as simply preposterous. It is not easy for us to realize how startling and absurd to him is the idea of cultivating anything for its green leaves alone. It may perhaps be compared to a suggestion to a European farmer that he should devote time and energy to keeping pigs solely for the production of bristle.

It is possible that a practical line of attack at the present stage might be the scattering of, e.g., amaranthus seeds in a backyard patch, on the grounds that it will be all the easier to gather the leaves if they are at hand there. Amaranths, and probably other unexacting indigenous plants, grow easily even out of season if given a little water, and persuading the native woman to throw the household waste water on to such a patch instead of just anywhere might not be too difficult a second step. Where, however, as sometimes happens, the dry season coincides with plentifulness of meat, fish, or other popular side dishes, so that no one will care whether green leaves are accessible or not, attempts at such persuasion would be so much wasted effort; and of course in the very arid areas of seasonally acute water shortage a backyard patch would seldom be a practicable proposition.

A point to be remembered in connexion with green vegetables generally is that they need a fatty relish to be palatable, and their consumption would in many cases be indirectly raised by an increase in the production or purchase of groundnuts, sesame, ghee or oils.

With the best will in the world, however, maintaining a supply of green vegetables through the dry season will in many places remain a matter of extreme difficulty, and as things are at present the intake of carotene and vitamin C is apt to fall periodically to undesirably low levels. The easiest source of supply during this difficult period is probably the pawpaw, which fruits through the dry season, and in fact nearly all the year, and contains both carotene and vitamin C in fair quantity. Another useful plant is the tomato, which grows with very little water, and will produce ample supplies of carotene and vitamin C for a household from a patch of land small enough for hand-watering to be practicable. It could be combined, perhaps, with the "greens" in the backyard patch in places where such a patch is possible. The Cape gooseberry, too, is a good source of vitamin C, and grows like a weed in most places with very little water.

Then there are mangoes as a source of carotene and citrus, the best known of all sources of vitamin C, both of them fruits which should be grown far more extensively than at present. Red peppers also are rich in carotene, and form the obvious seasoning in the case of a vitamin A-deficient population.

A source of vitamin C which is easy to tap in conditions which make fresh fruit and vegetables a practical impossibility is sprouted cowpeas and gram, as doctors with the East African forces have been finding. *Maharage* beans are no good for this purpose because they take too long to sprout and become mouldy, sour and evil-smelling before they are ready for eating. Gram and cowpeas, however, if kept moist and, preferably, in the dark, have sprouts about one and a half inches long after two days or so. They make a most palatable vegetable of delicate flavour, crisp and crunchy, and can be eaten uncooked or put into fast-boiling water for ten minutes and then seasoned.

The drying and storing of green vegetables, practised by some tribes to eke out their supply of side dishes, is a method of evening out supplies which, provided the essential food substances are retained, could usefully be greatly extended. Some experimental work on this is mentioned below.

Tastes

There is one aspect of food which is frequently ignored by nutritional writers and reformers—taste. It is useless trying to persuade people to eat foods or mixtures they do not like. A dish of fried eggs on slices of Christmas pudding with a tomato cocktail poured over it constitutes an ideally balanced ration, but it has not yet, so far as we know, appeared on any English table. Food is judged by ordinary people by palatability and attractiveness, and standards of palatability are largely determined by what people are used to. Though we know fairly accurately now what the African ought to have from the nutritional point of view, we have as yet little data on his food preferences,

favourite combinations of foods, ideas of good and bad cooking, special-purpose dishes, e.g. invalid cookery, etc. A close study of what he likes and dislikes, and of how his existing preferences can be turned to account in leading him to a better-balanced diet, is an essential step in the busines of solving the educational and psychological problems involved in nutrition.

Simple classification and precepts

We are not, however, entirely ignorant. A good African meal is made up of several classes of foods. First, there is *chakula,* the main dish, meal porridge, rice, sweet potatoes, boiled bananas or cassava. This part of the meal is "what fills you up"; it produces that sense of distension without which the native does not feel satisfied.

But it needs a side dish, either *mboga* (beans, gram, pumpkin, green leaves, etc.) or *kitoweo* (fish, meat, poultry), or both. Then there are *viungo* (literally "joiners"), ingredients which pull the dish together, viz. spices, salt, oil, ground and roasted groundnuts, onions, etc., all those things which give the food flavour and make it appetizing.

The native classification of food into (1) *chakula,* (2) *mboga,* (3) *kitoweo,* (4) *viungo,* is a very simple one and very useful, because by adopting it we can avoid all complicated phraseology and, to the African, meaningless nomenclature. We can then reduce good feeding to three simple rules for him, based on this classification with the addition of fruit. They are: (1) Eat daily something from each of the four classes and some fruit whenever possible; (2) Vary the diet as much as you can within each class; (3) Eat plenty of all.

A well-balanced native diet is no more and no less than that, but in order to keep to these rules the peasant must of course grow enough of a sufficiently varied assortment of crops and he must maintain a regular supply of the different classes of foods, either by spreading his crops throughout the year as much as conditions allow, or by storing them for his own future use, or by a system of agricultural specialization and produce exchange, or, probably most satisfactorily, by some combination of all three.

Storage problem

The chief trouble lies not in achieving adequate total production but in maintaining reasonable regularity in the supply, and for this efficient storage is essential. Unfortunately, we have as yet little accurate information about the storage of food by natives under different conditions. We do know that grain losses from insects and vermin are far too high, but serious as this is, it is probably not so serious nutritionally as the failure in most cases to store the subsidiary crops in a manner which will preserve the essential food substances they contain. This problem is primarily a chemical one and must in the first instance be tackled in the laboratory. Its importance can scarcely be over-stressed, and it is to be hoped that research work of this nature will be pushed ahead as soon as possible. A useful start was made by J. C. Eyre in experimental drying and baling of green leaves, with laboratory examination by Raymond to discover how far the nutritionally important substances are being conserved; and the results so far appear very promising.

Conclusion

Two facts emerge from the foregoing pages. In the first place, there exist serious gaps in our knowledge of African nutrition which only research can fill, but on the other hand we are not making full use of the data which we already have. For the time being therefore our obvious course is to apply the knowledge we have in effecting such improvements as are possible under present world conditions, hoping that eventually it will be possible for research to go forward once more, to strengthen the factual basis on which alone a rational policy of African nutrition can be built.

Summary

This paper attempts to translate into terms of East African peasant agriculture the biochemical conclusions of Dr. W. D. Raymond in his paper "Minimum Dietary Standards for East African Natives" (*E. Afr. Med. J.*, 17, 249). It first considers the common grains, emphasizing the danger of regarding them as simply interchangeable without reference to the equilibrium of the diet as a whole, and then goes on to a discussion of sweet potatoes and cassava, referring to recent unpublished work of Raymond's on the latter, in which he shows the tubers to contain appreciable quantities of vitamin C. It is also pointed out that the cyanogenetic compounds the tubers contain, which have caused some alarm, are removed by proper preparation. The paper continues with a survey of the subsidiary food crops of the country and their place in a properly balanced peasant dietary, considering them under the heads of fats, protein, minerals and vitamins. There follow short sections on

the importance of palatability, on simple precepts based on native classification of foods, and on the storage problem, with the general conclusion that while there remain many gaps in our knowledge the chief need of the moment is to apply what we already know.

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[4] F. H. King.—*Farmers of Forty Centuries*, London, 1939 (reprinting), p. 121.

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APPENDIX

Summary of Dr. Raymond's paper, "Minimum Dietary Standards for East African Natives," *E. Afr. Med. J.*, Vol. 17, pp. 249-265, 1940:—

(1) The net calorie requirements of the East African male, calculated from his surface area, are estimated to be 2,525 calories with eight hours' moderate work and 3,260 calories with hard work. Slightly higher figures of 2,600 and 3,400 are suggested as standards.

(2) An attempt has been made from data of the heights and weights of African boys to compare their metabolism (expressed as a fraction of that of the adult) with that of American boys. The metabolism of African boys is proportionately lower at all ages, the percentage varying from 1 per cent to 12 per cent. It is not thought that any great error will be made by using the coefficients applicable to Europeans if they are calculated from the revised estimate for the African adult given above.

(3) Very little of the protein eaten by Africans is of animal origin. On this account the protein content should be higher than European standards. A 100-gram standard is suggested, and if possible at least 10 grams animal or fish protein should be included. A 50-gram standard for fat is proposed.

(4) African diets are all low in calcium (about 0.3 gram). A provisional standard of 0.5 gram is suggested. Green leaves are comparatively rich in this element, but should not contain much oxalic acid if they are to be successfully utilized as a source of calcium. The high phytin content of African diets is noted and a standard of 1.0 gram total phosphorus suggested for use with the above calcium one. A 20-milligram standard for iron is proposed.

(5) The provisional vitamin standards for the African are given as: A, 3,000 International Units (high here on account of the low fat in the diet and the vegetable origin of the vitamins); B_1, 10 International Units per 100 calories; C, 30 milligrams (absolute minimum in cooked foods, 10 milligrams). The requirements for nicotinic acid are discussed. Vitamin D and E content of African diets are not assumed to be deficient. (Vitamin D intake is, of course, low, but the high exposure to radiation will compensate.)

(6) Diets for Africans should be examined from the viewpoint of their energy value and their content of vegetable and animal protein, fat, calcium, phosphorus, iron, vitamin A, B_1 and C, and as soon as sufficient analytical data are available, also as to their nicotinic acid content.

In his *Man and Nature* (New York, 1864, p. 24) George Marsh wrote as follows: "There is one branch of research which, from the great difficulty of direct observation upon it, has been less successfully studied than almost any other problem of physical science. I refer to the proportions between precipitation, superficial drainage, absorption, and evaporation. Precise actual measurement of these quantities upon even a single acre of ground is impossible; and in all cabinet experiments on the subject, the conditions of the surface observed are so different from those which occur in nature that we cannot safely reason from one case to the other." The problem thus stated by Marsh is the one to which the climatologic work of Thornthwaite's section of the Soil Conservation Service [United States Department of Agriculture] is addressed. For seventy-five years that "impossible" has stood; now, from all indications, it is nearly ready to join many other "impossibilities" in the scientific rubbish heap.

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THE NUTRITIVE VALUE OF SOME TANGANYIKA FOODS

II—CASSAVA

By W. D. Raymond, B.Sc., Ph.D. (Lond.), F.I.C., W. Jojo, B.Sc. (S.A.), and Z. Nicodemus (from the Chemical Laboratory, Dar es Salaam)

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The cassava root (*Manihot utilissima*; Swahili, *muhogo*) is an important famine reserve crop in Tanganyika. A recent book on tropical nutrition assesses the nutritive value of the fresh root as follows:—

Caloric value 145 per 100 g.

Calcium .04, Phosphorus .04, Iron .001 per cent.

Vitamins A, B_1, B_2 and C—very little.

Clark has suggested that the presence of cyanogenetic glycosides in the root and leaves precipitates or causes pellagroid symptoms. In experiments on animals described in support of this statement, rats were fed on minced bitter cassava leaves, forming from three-quarters to the whole of their diet (excluding mineral supplements) and on raw and steamed cassava root. In all cases loss in weight, and in some cases death, followed. Harris and Raymond have cited evidence to show that rats excrete nicotinic acid on a nicotinic acid deficient diet, and Birch and others have shown that on a Goldberger diet rats can live without added nicotinic acid. It is thus doubtful if rats could show symptoms of pellagroid disease. Nevertheless, in view of these reports we decided to investigate the place of the cassava plant, both root and leaves, in East African diets, paying particular attention to the presence in it of cyanogenetic glycosides.

We wish to thank the Director of Medical Services, Tanganyika Territory, for permission to publish this work.

A—The root

The importance of cassava as a food crop in East Africa lies in the fact that, unlike sweet potatoes, the other common tuber, it is not seasonal.

The root is used by Africans in at least four ways:—

(1) Raw in small quantities as a "snack" and thirst quencher; only the sweeter varieties are so used.

(2) Boiled until tender.

(3) Roasted.

(4) In the dried form as flour to replace maize and other cereals.

The place of the cassava root in African nutrition is thus twofold: first as a supplement of the tuber type replacing sweet potatoes, and secondly, as a staple. Though a great deal of attention has been paid to this second use, and we are satisfied that in this form it is less nutritious than other staples such as maize or rice, less appears to have been paid to its use as supplement.

The relatively high indophenol titration given by the fresh root attracted our attention, and so far as we are aware this is the first report of the presence of vitamin C in the root; the mean value obtained from several varieties of differing degrees of freshness being 30 mgm. ascorbic acid per 100 grams of root.

We sought confirmation of this result by preparing qualitatively the 2:4 dinitrophenylhydrazone and by feeding experiments on guinea pigs who were given 1.8 gm. of the fresh root daily, corresponding to .54 mgm. ascorbic acid, their minimum requirements being generally accepted as 0.5 mgm. The results of this experiment are shown in Table I.

Table I

Animal No.	Diet	Weight of animal in grams after days									
		0	7	17	20	22	31	38	45	61	75
1	Basal	230	225	207	182	145	Died of scurvy 22nd day.				
2	Basal	210	255	250	225	195	Ditto.				
3	Basal plus 1·8 g. fresh root ..	180	180	215	229	—	242	243	255	260	288
4	Ditto	330	302	312	333	—	313	320	338	356	360
5	Ditto	260	245	260	263	—	248	266	305	288	278
6	Ditto	240	215	260	275	—	300	345	364	360	400

TABLE II

Source	T.T.	T.T.		Kenya	U.S.A.	Cen. Africa	Tropical
Author	Present work Variety (*Mambo leo*)	French A	French B	Gilks and Orr	Ewell & Wiley Peeled roots	Leitch	Nicholls
Water per cent	60·3–63·8	—	—	—	61·3	60 (assumed)	62
Crude protein	2·46	3·06	3·63	4·69	1·65	1·32–4·92	1·84
Ether extract or Digestible fat	— 0·08	0·99 —	6·02 —	— —	0·44 —	0·1–0·87 —	1·31 —
Carbohydrate (by diff.) or Available (carbohydrate)	— 76·0–81·0	86·6 —	85·4 —	— —	— 79·8	30·5–98·7 —	92 —

TABLE III

	Whole peeled root *Mambo leo*	Mixed peeled roots *Mambo leo*	Peeled root *Mambo leo*	Peeled root *Bwana mrefu*
Per cent water	63·7	0·0	0·0	0·0
Reducing sugars	—	—	—	—
Total sugars and sucrose	1·07	—	—	—
Starch (taka diastase method)	26·51	—	—	—
Starch (acid hydrolysis)	25·19	—	—	—
Total carbohydrate after acid hydrolysis without prior separation sugars	—	77·0	80·0	81·0

We consider these results as satisfactory confirmation of the presence of ascorbic acid, whose occurrence, based on chemical assay, is discussed in greater detail below.

Other constituents of the root are also discussed under their respective heads, and since the African only consumes the peeled roots all our results refer to them, unless specifically stated.

Fat, protein, carbohydrate and water

The comparison of our own figures for fat, protein and carbohydrate and those of other writers have been made on a water-free basis.

In two samples we found the titratable acidity to be 20 and 23 mls. respectively of decinormal soda per 100 g. root.

The general agreement on the amount of water present in the root is good. Our own figures, quoted above, were determined at 50° C. and are close to a second set determined at 100° C. Protein probably varies and a figure of 2.5 is selected for general use. Our figures for fat and carbohydrate are lower than most published, which we believe is due to the methods of analysis employed. Our figures for fat, which apparently occurs in negligible amount, refer to saponifiable fat determined by McCance's method, whereas other workers have determined ether extract. Our figures for carbohydrate, which are given in Table III in greater detail, were also determined according to the methods of McCance.

For ordinary dietary calculations, involving the raw, boiled, or roasted root, we suggest that the following figures may be used: Water, 62; protein, 0.7; fat, nil; carbohydrate, 30; calories per 100 g., 123.

Minerals

We have limited our work to calcium, phosphorus and iron, and obtained the following figures: Calcium, 31.26 to 51.35; phosphorus, 104.6 to 199.5; iron, 0.18 to 0.37 mgm. per 100 g. root.

Our figures for phosphorus are higher and those for iron rather lower than most published figures, while those for calcium agree with other analyses. As usual, we ground our samples in a porcelain mortar. After making allowances for the fact that our results are for the peeled root, while those of other workers are for the whole root, we do not consider that there is any appreciable difference of nutritional importance between the different sets of figures.

Vitamin C and cyanogenetic glycosides

We discuss these together because the main interest of the present work has been in these two constituents. Several writers have noted that more cyanogenetic glycosides are present in the peel than in the peeled root, and the figures in Table IV confirm this, but show that, fortunately, the converse is true for vitamin C.

TABLE IV

Variety and Part	Ascorbic acid mgm/100g.	Cyanogenetic glycosides as HCN mgm/100g.
Mambo Leo—		
Whole	35·0	11·3
Skin	23·6	33·5
Skinned	38·9	1·9
Akiba si mbaya—		
Whole	—	18·0
Skin	—	23·0
Skinned	—	12·0
Mambo Leo	54·6*	11·3†
Skinned and boiled	32·7	—
Uganda No. II—		
Whole	39·9	39·6‡
Skinned and boiled	19·9	0·7
Constantin—		
Whole	—	33·2‡
Skinned and boiled	—	0·1
Mambo Leo—		
Skinned	30·9	4·1
Roasted and then skinned	25·9	0·6
Bwana mrefu—		
Skinned	44·5	—
Roasted and then skinned	47·3	—

*Skinned. †Whole. ‡Selected for high HCN value

The above results show that on boiling the peeled root about one-half the ascorbic acid is lost. Even in the so-called bitter roots (these are only relatively bitter and their cyanogenetic glycoside content is much lower than toxic varieties reported elsewhere) the amount of cyanogenetic glycosides remaining after boiling is negligible.

On roasting with the peel on there is only a slight loss of ascorbic acid. The Swahili may first roast the tuber and then peel it, or vice versa, according to the nature of his fire, but in either case the cyanogenetic glycosides are destroyed during the process, rendering the food innocuous.

By the courtesy of the Director of Agriculture we received a large number of different varieties of cassava from Morogoro and Tabora. We have analysed the whole root of these and obtained the results shown in Table V.

TABLE V

Variety	Ascorbic Acid mgm/100g.	Hydrocyanic Acid mgm/100g.
Mandioca Sao Pedro Preto 239 (Fed. Malay States)	31·6	—
A6 (Amani seedling)	—	19·4
A19 (Amani seedling)	—	10·5
A23 (Amani seedling)	19·7	5·8
A31 (Amani seedling)	—	6·4
A50 (Amani seedling)	—	38·8
Akiba si mbaya	—	18·0
Ankrah (Gold Coast)	24·6	—
Bihanga (Ruvu)	16·2	9·7
Biligiji (Dar es Salaam)	—	14·3
Binti Asumani	17·6	—
,, ,,	21·7	11·6
,, ,,	26·3	6·4
,, ,, No. 12 (Bagamoyo)	—	17·5
,, ,, (Kilosa)	—	7·2
,, ,, (Kisangile)	—	27·1
,, ,, (Lindi)	—	13·6
,, ,, (Msonga)	—	6·7
,, ,, (Tabora)	36·0	43·4
Binti Kaniki No. 15 (Bagamoyo)	—	1·6
Binti Minsi (Uganda)	27·1	19·7
Bitter (Mauritius)	43·9	—
Blue beard (Mauritius)	21·4	—
Bukini No. 4 (Bagamoyo)	30·2	9·9
Bukini (Mvomelo)	17·2	6·2
Bunch of keys (F.M.S.)	37·8	10·8
Bureum	39·2	—
Bwana mrefu (Tanga)	26·2	10·9
Chakupewa (Kisiju)	—	28·9
Chikulo ya Nyiga No. 2 (Bagamoyo)	—	25·1
Cotton tree (Mauritius)	41·1	28·6
Dadi Rashidi (Dar es Salaam)	—	3·1
Dizelu (Morogoro)	—	8·3
F 279 (Java)	32·4	20·7
Gabriel (Lindi)	29·4	8·3
Goza (Kisiju)	34·4	14·2
Gunia No. 10 (Bagamoyo)	—	26·7
Kabangi (Tabora)	21·9	22·1
Kabangi	23·7	32·4
Kajamwenyewe (Morogoro)	25·9	—
Kalulu	27·8	9·4
Kalulu (Tabora)	37·8	12·1
Kandilunya (Lushoto)	16·7	19·9
Kandinya (Tanga)	37·4	12·6
Kandiziuje (Bagamoyo)	—	6·6
Kaniki	—	10·8
Kaniki (Dar es Salaam)	41·8	—
Kaniki (Lushoto)	29·4	9·7
Katula P No. 1	—	18·3
Katula P III	20·5	—
Katula P IV	34·3	9·9
Kasunga (Lushoto)	24·6	7·8
Katope (Lushoto)	17·7	3·7
Kayeba	18·6	21·6
Kibuluu (Kisiju)	27·3	7·1
Kibuluu (Kisangile)	38·2	22·6
Kichunga (Tanga)	—	28·2
Kijiti variety (Zanzibar)	34·8	—
Kijunia	—	16·0
Kinyasa No. 4	22·8	14·7
Kitambo (Tanga)	22·7	11·0
Kitulaganda (Tabora)	—	19·6
Kullu	29·9	—
Lide (Tanga)	—	17·0
Liongo (Tabora)	27·1	30·4
Liongo (Tabora)	37·9	—
Lumango	—	18·9

TABLE V—(*Contd.*)

Variety	Ascorbic Acid mgm/100g.	Hydrocyanic Acid mgm/100g.
Maanwano (Dar es Salaam) ..	—	4·3
Magongo (Dar es Salaam) ..	32·9	—
Majalimba (Iringa)	30·9	—
Makuga (Dar es Salaam) ..	26·0	16·6
Mambo Leo (Dar es Salaam)..	27·9	—
Mambo Leo (Kisangile) ..	—	18·9
Mandarumbi (Dar es Salaam)..	34·7	12·4
Mangi (Java)	37·8	—
Mbalika (Tanga)	29·7	—
Mbemba (Tanga)	22·4	9·4
Mbiriti (Tanga)	21·5	12·5
Mbiru (Kisiju)	32·9	16·4
Mbokwe (Tanga)	36·9	—
Mbuluu (Msonga)	22·7	3·2
Mbuyu (Dar es Salaam) ..	34·8	—
Mbwani (Lindi)	25·4	—
Mbwani (Dar es Salaam) ..	—	13·8
Mgaila (Kilosa)	25·6	—
Mgaraganza	18·1	14·5
Mgindo (Msonga)	—	8·3
Mjenga (Kisiju)	20·0	10·5
Mkabulu (Uganda)	—	30·2
Mkali wa tamu (Dar es Salaam)	41·2	21·8
Mkobo (Dar es Salaam) ..	43·3	—
Mlopoka (Dar es Salaam) ..	29·5	14·3
Moshiwataa (Bagamoyo) ..	35·2	11·3
Mpandika (Dar es Salaam) ..	—	9·1
Mpapae (Kisiju)	31·6	24·0
Msangela (Dar es Salaam) ..	32·5	9·1
Msitu (Zanzibar)	20·9	—
Mtumbati (Dar es Salaam) ..	20·0	12·3
Mwali (Lushoto)	22·7	8·2
Mwanga (Kilosa)	—	24·5
Mzaramo (Ruvu)	25·9	17·0
Mzungu (Mulela)	23·0	13·7
Namtalotulo (Lindi)	12·3	—
Ndogawe	22·6	9·7
Ndunga (Dar es Salaam) ..	37·3	—
Ndunga (Msonga)	26·3	7·6
Ndunga No. 9 (Bagamoyo) ..	—	28·0
Nodewide (Uganda)	24·4	13·2
Nodewide (Uganda)	26·7	18·3
Numbu (Uganda)	—	18·3
Nusumwaka	23·9	12·0
Nyaluluma (Mwanza) ..	—	28·2
Nyamlanbange (Dar es Salaam)	52·4	—
Nyanjige (Tanga)	27·9	12·6
Pesazi (Kilosa)	37·8	—
Rumango (Ruvu)	43·5	34·8
Shaurimoyo (Kisiju)	24·9	16·9
Shaurimoyo	24·9	9·2
Shina rupia	—	21·7
Shindano (Mvomero)	42·5	20·7
Sinagunia (Tanga)	40·7	22·9
Tolo	22·9	8·6
Trinidad No. 1 (Mauritius) ..	25·5	9·3
Trinidad No. 2 (Mauritius) ..	40·3	—
Trinidad No. 3 (Mauritius) ..	—	8·1
Turkey No. 17 (Bagamoyo) ..	—	17·3
Uganda No. II (West Indies)..	39·9	39·6
Uganda No. V (West Indies)	—	9·9
Upamba (Tanga)	31·6	—
Yaidi mhogo No. 1	—	33·2
Yellow bell (Mauritius) ..	36·4	—

Cyanogenetic glycosides calc. as HCN	Max.	43·4 mgm/100g.
(101 varieties examined)	Min.	1·6 ,,
	Mean	15·8 ,,
Ascorbic acid	Max.	52·4 mgm/100g.
(91 varieties examined)	Min.	12·3 ,,
	Mean	29·3 ,,

A single root (Mambo Leo) was stored at laboratory temperature for five days. Samples for analysis were taken by cutting a complete section. The ascorbic acid content at different times were found to be as follows:—

Fresh	.. ..	21·3 mgm/100g.
1 day	.. ..	31·2 ,,
2 days	.. ..	19·9 ,,
3 days	.. ..	25·3 ,,
6 days	.. ..	21·1 ,,

The ascorbic acid content of the root varies, but no appreciable destruction on storage can be assumed as the result of this experiment.

Three samples of cassava flour purchased locally gave on analysis the results shown in Table VI.

TABLE VI

	HCN mgm/100g.	Ascorbic Acid mgm/100g.
No. 1	0·71	1·7
No. 2	0·16	1·7
No. 3	0·27	1·4

B—THE LEAVES

Fresh cassava leaves are sold in the Dar es Salaam market, and are much used by Africans in a cooked dish known as *kisamvu*. Their high ascorbic acid content was noted by this laboratory in 1937, and more recently Van Veen has made a careful investigation in which he reports the fresh leaf to contain 13,000 I.U. vitamin A, 100 to 110 I.U. vitamin B_1, 145 to 185 mgm. vitamin C, and 430 micrograms lactoflavin per 100 g. The leaves were found to contain less hydrocyanic acid than the root (0.02 per cent), and cooking removed it. The African boils the leaves until tender, with a small amount of water. In experiments in this laboratory the average period of boiling needed was found to be one and a half hours, which we accordingly adopted as a standard in the present work. The leaves are sold in the market in small bunches. Before cooking, the native removes the leaf stalks, and we have done the same, so that our analyses (Table VII) relate to those portions of the leaf accepted as edible by the African.

TABLE VII

	Raw		Cooked
	Present work	Van Veen	Present work
	Per cent	*Per cent*	*Per cent*
Water	73·6	77·0	88·3*
Total nitrogen ..	1·17	—	1·31
Crude protein ..	7·33	8·2	8·2
Digestible fat ..	0·69	1·2	n.d.
Titratable acidity ..	90 mls. N/10	—	n.d.
Total sugars and sucrose	3·28	—	n.d.
Starch	3·47	—	n.d.
Soluble carbohydrate	n.d.	3·3	n.d.
Total available carbohydrate	6·75	—	n.d.
Ash	1·71	—	2·4
Total phosphorus ..	0·098	0·131	0·142
Calcium	0·187	0·2	0·352
Iron	0·003	0·007	0·003

* This sample before cooking analysed 69·8 per cent water.

As in the roots, our main interest in the leaves has been in their hydrocyanic and ascorbic acid content. The former varied from 28.6 to 24.5 mgm HCN per 100 g., while the figures in Table VIII were obtained for the ascorbic acid content.

TABLE VIII

	mgm/100g.
Fresh leaves from the plantation	325·6–381·4 (mean 353·2)
Raw leaves from the market	247·6
Leaf stalk only	39·7 ; 39·3
Leaf after one day's storage	75·1
Leaf after two days' storage	45·1
Leaf after three days' storage	37·5
Before cooking	247·6
After cooking	248·1 (corrected for gain in water content)

These results show that whereas the leaf stalk contains only a small amount of ascorbic acid, the leaves themselves are one of the richest sources known, but that once picked they lose ascorbic acid fairly rapidly at tropical room temperatures. The losses on cooking are, however, slight, which may be due in part to the high natural acidity of the leaf. The pH of the juice and cooking water after boiling was 5.3. If after cooking the whole mass is squeezed in a clean cloth, the juice so obtained contains 212.7 to 215 mgm. ascorbic acid per 100 mls. This may be concentrated under reduced pressure (an ordinary water pump was used) to form a pourable concentrate containing over 2,000 mgm. per 100 g., a preparation tasting somewhat like "Marmite" and which appears to keep well. After twenty days' storage in a partially filled bottle at room temperature only a slight loss in ascorbic acid occurred. Another method of preserving the leaf consists of cooking it with chillies and tomatoes and bottling.

The hydrocyanic acid content of the leaf is rapidly destroyed on boiling (*see* Table IX).

TABLE IX

Period in Hours	Experiment 1 HCN mgm/100g.	Experiment 2 HCN mgm/100g.
0 hour	18·6	24·5
Quarter-hour ..	1·8	0·8
Half-hour ..	0·0	0·0
One hour ..	0·0	0·0
One and a half hours ..	0·0	0·0

The oxalic acid content of the leaves was determined by the method we have previously described. The results obtained in four separate samples were: 126.0, 109.4, 101.3 and 99.0 mgm. per 100 g., with a mean of 108.9.

The carotene content of the leaves was found to be 9,746 to 11,136 micrograms per 100 g. in the fresh state and 7,172 micrograms after cooking, or 9,000 micrograms when corrected for increase in weight on cooking, which shows that boiling results in but little loss of vitamin A.

REPRESENTATIVE VALUES

We suggest the representative figures in Table X (all expressed per 100 g. of material) for use in dietary calculations involving Tanganyika material.

TABLE X

	Fresh Root	Dried Root	Leaves (Without stalks)
Water ..	62	12	74 g.
Carbohydrate	30	70	5 g.
Fat	—	—	0·7 g.
Protein ..	0·7	1·6	7·5 g.
Calcium (Ca) ..	0·04	0·1	0·1 g.
Phosphorus (P)	0·1	0·2	0·1 g.
Iron (Fe) ..	0·000	0·001	0·003 g.
Ascorbic acid	30	Nil	300 mgm.
Carotene ..	v.l.	v.l.	10,000 micrograms
Oxalic acid ..	—	—	100 mgm.
Calorie value ..	123	286	56

SUMMARY

The root of the cassava plant in its fresh state is a source of ascorbic acid comparable with the sweet potato. Its cyanogenetic glycoside content varies according to variety and cultivation, but most Tanganyika varieties do not contain much. The hydrocyanic acid is destroyed on roasting or boiling. The protein and mineral content of the root is low, and it contains a negligible amount of digestible fat.

The leaf also contains cyanogenetic glycosides, but these are destroyed by African methods of cooking. It is one of the richest

sources of vitamin C, while it also contains appreciable amounts of carotene, losing little of either of these substances on cooking. It is also rich in calcium, but contains oxalic acid. The inclusion of both the fresh root and the leaf makes a most valuable addition to African diets and every encouragement should be given to the use of cassava as a supplement to the main staple. The dried ground root is not valuable as a staple, but no doubt has its place as a famine food.

By extracting the juice from cooked leaves and vacuum concentration, preparations that appear to keep well, containing upwards of 2,000 mgm. of ascorbic acid per 100 gm., may be obtained. The cooked leaf may also be preserved by home bottling methods.

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FACTORS INFLUENCING THE FERTILIZATION OF EGGS

There is a mass of data on the relation between fertilization and the age of the birds used for breeding purposes. Unfortunately, conclusions drawn from these data are very vague and no fixed rule can be deduced. It has been found that a greater percentage of fertilized eggs with a greater viability results from the mating of young cocks and old hens than from the mating of young hens and young cocks. In the case of Leghorns it has been found that fertilization declines as the birds become older. Among Rhode Island Reds fertilization was the same in the case of one-year and two-year old hens, but declined in older hens. In the case of Banded Plymouth Rocks, however, fertilization was better among two-year old than among one-year old hens. A curious phenomenon is that young cocks produce just as good fertilization early in the season as late in the season. Old cocks, on the other hand, give better results later in the season than at the beginning. Cold weather apparently affects old cocks more than young ones. Fertilization seems to be the same in the case of both young and old hens, early as well as late in the season. It is clear therefore that, as regards fertilization, hens are affected much less by weather and climatic conditions than are cocks.

The best results as regards fertilization were obtained when two-year old cocks were mated to two-year old hens. In this respect old cocks gave the best results with one-year old hens. Apparently cocks lose their fertilizing ability sooner than hens, but if such birds are well fed and cared for, it would seem as if old cocks nevertheless give satisfactory results.

In breeding pens, where fertilization is normal, hens are sometimes found which produce infertile eggs. The fault might lie with either the cock or the hen. There may be some anatomical defect, or mating with certain hens may not take place at all. In that case better results are sometimes immediately obtained by putting the hen into another pen.

With heavy breeds such as Rhode Island Reds no difference in fertilization was noticed whether a cock was mated with one or with fourteen hens. For practical purposes, however, it is recommended that one cock should be mated to eight hens in the case of all heavy breeds, such as Australorps, Rhode Island Reds, etc., and one cock with ten to thirteen hens in the case of light breeds such as Leghorns. Naturally the condition and age of the cock will always have to be taken into consideration.

It appears that it is possible to raise hatching results by breeding, but unfortunately this cannot be said of fertilization, and it would seem that fertilization capacity is not hereditary.

Feeding naturally plays an important part, as it directly affects the health of the birds. It was found that one of the vitamins of the B group is essential for the success of fertilization and hatching results, yet its absence will have no direct injurious effect on full-grown birds (Antidermatosi).

The general treatment which fowls receive is a very important factor which cannot be ignored, and is sometimes the source of the trouble. Good results cannot be expected from birds that are poorly housed and badly managed. Cocks covered with lice, for instance, gave completely negative results, yet as soon as the fowls were rid of this pest fertilization was normal. Nor can good results be expected from cocks with sores underneath their feet.—Extract from an article by P. J. Serfontein in *Farming in South Africa*, Vol. XV, No. 171, p. 217, June, 1940.

A NOTE ON THE YIELD OF TUNG TREES IN NYASALAND

By C. C. Webster, B.Sc., A.I.C.T.A., Department of Agriculture, Nyasaland

1—Age and acreage of tung in Nyasaland

Tung seed was first introduced into Nyasaland in 1928, when the Forestry Department received from Kew 10 lb. of seed of *Aleurites fordii*. This seed was planted in small trial plots at Dedza, Limbe and Zomba. More seed of this species was imported in the following year and the distribution of small quantities to planters all over the country was begun. The original plantations made by the Forestry Department are still in existence, but they have been maintained under forestry conditions receiving little or no cultivation; in consequence growth has been relatively poor and the yields cannot give much indication of what may be expected from properly cultivated plantations. The majority of the early trial plots planted on European estates have either been more or less neglected or abandoned entirely, and in many of them few trees now survive. Yield data are not available from any of these plots. There are very few trees of this species in the country over seven years old which have been properly cared for, and the majority of the *fordii* acreage is not older than five or six years.

Seed of *Aleurites montana* was sent out from Kew in 1929 and again in 1930, but failed to germinate on arrival. A third consignment was obtained from China via Kew in 1931, and this time the seed germinated well. Most of it was planted at the Department of Agriculture's Experimental Station at Zomba, but small quantities were sent to three or four planters. Yields are available from the trees at the Experimental Station and from two of the plots on estates. Apart from these plantings the whole of the acreage under *montana* is not more than five or six years old, and most of it ranges from one to four years old.

Since 1931 further importations of seed have been made and the acreage under tung in the Protectorate has steadily increased. In the early years, *Aleurites fordii* was the species mostly planted, but more recently the majority of new plantations have been of *Aleurites montana*. Table I shows the acreage under tung at 31st December of each year from 1932 onwards, according to returns made to the Department of Agriculture. No figures are available for the acreage under each species.

Table I

Acreage under tung in Nyasaland

Year	1932	1933	1934	1935
Acres	51	65	184	341
Year	1936	1937	1938	1939
Acres	624	1,171	2,068	4,356

2—Yields

As will be seen from the foregoing, even the oldest tung trees in Nyasaland have not yet by any means reached full bearing, and only a small acreage has yet got beyond the stage of just beginning to bear. It is therefore evidently impossible at present to do more than obtain some idea of the yields given by trees in their first few years of bearing. This is especially true of *Aleurites montana*, but is almost equally applicable to *Aleurites fordii*, since the majority of the oldest plots of this species have either been abandoned or have been maintained in such a manner that their yield figures, if available, would be of little practical value. This season, however, yields have been accurately recorded from a small number of plots of the oldest trees of both species, and the figures obtained are shown in Table II. The yields from Plot 1, which consists of 123 trees at the Zomba Experimental Station, have been recorded ever since the trees started fruiting, and are shown in Table III.

Table II

Yields of tung trees in Nyasaland

Plot No.	Number of trees in plot.	Age.—Years	Planting distance	Number of trees per acre	Lb. dry seed		Lb. oil per acre.
					Per tree	Per acre	
A. montana							
1	123	8	30′ sq.	48	13·8	662	232
5	45	8	30′ sq.	48	10·8	518	181
2	18	8	36′ sq.	34	26·1	887	310
A. fordii							
10	50	10	12′ sq.	302	3·31	1,000	370
9	50	8	30′×15′	97	3·35	325	120
7	50	7	30′×12′	121	2·45	296	109
4	50	7	25′ sq.	70	1·80	126	47

TABLE III

YIELDS OF 123 *Aleurites montana* TREES AT ZOMBA EXPERIMENTAL STATION

Age–Years ..	3	4	5	6	7	8
Lb. dry seed per tree	1·75	3·6	5·20	9·46	11·0	13·8
Lb. dry seed per acre	94	173	250	454	528	662

The yield per acre is simply the average yield per tree multiplied by the theoretical number of trees per acre at the spacing adopted in the plot. The oil yield is calculated on the assumption that dry seeds of *montana* contain 35 per cent of extractable oil and those of *Aleurites fordii* 37 per cent. Two of the *montana* plots (Nos. 1 and 5) are in Zomba district, and trees of *Aleurites fordii* planted adjacent to those plots have now almost entirely died out, the few remaining yielding practically nothing. The general growth of tung trees is better under the higher rainfall of Cholo district, and it therefore seems probable that better yields will be obtained there than at Zomba. All the *fordii* plots are in Cholo. The yields of the *montana* plots are in each case the average yields of the whole of a small plantation, whereas the *fordii* plots are blocks of fifty trees each selected (not primarily for yield recording) in the best part of a much larger field, and the plot yields are therefore not really representative of the yields of the plantations in which they are situated. The *fordii* plot No. 10 is on very good soil, but it is probable that the high yield will not be maintained as these closely planted trees now have their branches well interlaced and require thinning. In contrast, there is still a fair amount of room for expansion in all the *montana* plots. Bearing these considerations in mind, it will be seen that any comparison of the two species based on the figures of Table II is definitely biased in favour of *Aleurites fordii*. Nevertheless, the figures show that all the *montana* plots have given a very much greater yield per tree than the *fordii* plots, and that on the average *montana* has given over 50 per cent more seed per acre than *fordii* in spite of the latter species being planted much more closely. It may be mentioned that, so far as can be judged from the appearance of these older plantations, trees ten years old will require a spacing of about 30 feet for *montana* and 18 to 20 feet for *fordii*.

Too much importance must not be attached to the yields from a few small plots, but it nevertheless seems justifiable to conclude that *Aleurites montana* is the more promising species and that it may be expected to yield considerably more per acre than *fordii*, in spite of the much closer spacing which may be adopted for the latter. This conclusion is well supported by the general appearance of plantations of the two species growing in Cholo district, for while there are a certain number of *fordii* fields which have made remarkably good growth, there is no doubt that generally speaking *Aleurites montana* has made relatively much more satisfactory growth and appears healthier and more suited to local conditions than *fordii*. The yields so far obtained from plots of *Aleurites montana*, all of which have been established from unselected seed, give every promise that such plantations will prove profitable. The *fordii* yields indicate that this species may also be profitable under favourable conditions, although less so than *Aleurites montana*, but the appearance of much of the whole acreage under *fordii* makes one doubt if it will generally pay its way. It is unlikely that the difference in price between the two oils will be more than £3 to £4 per ton, and it seems evident that the slightly higher price likely to rule for *fordii* oil will be much more than balanced by the greater yield per acre obtainable from *montana*.

3—VARIATION IN YIELD BETWEEN INDIVIDUAL TREES

In all the above plots the fruit from each tree was weighed separately and, as was expected, it was found that trees varied very considerably in their yields. Among the 186 trees of *Aleurites montana* in the three plots the yields varied from nothing up to 79.4 lb. of seed, with a mean of 14.3 lb., while the 200 *fordii* trees gave from nothing up to 12.5 lb., with a mean of 2.70 lb.

There are doubtless a number of factors, both genetic and environmental, which combine to produce this variation in yield between trees, but, as far as *Aleurites montana* is concerned, by far the most important cause is the well-marked variation in flowering habit, which I believe to be mainly a genetic feature. Trees of this species are normally monoecious, but they may bear inflorescences which are entirely male, entirely female, or which contain flowers of both sexes, and the proportion of male and female blossom varies from tree to tree. This feature was studied at the Tuyen Quang Experimental Station in Indo-China in 1929 and 1930 by estimating the number of male and

female flowers on 599 trees, and the figures given in Table IV were obtained [1].

TABLE IV

CLASSIFICATION OF 599 *Aleurites montana* TREES IN INDO-CHINA BY PERCENTAGE OF FEMALE FLOWERS

Percentage of female flowers	Percentage of trees in each category	
	1929	1930
	Per cent	*Per cent*
0	29·5	22·8
0–5	15·8	22·0
5–15	4·8	5·5
15–25	3·8	3·7
25–40	2·8	2·5
40–60	4·8	3·8
60–75	2·5	3·3
75–85	2·8	2·2
85–95	3·5	4·2
95–100	9·7	14·3
100	20·0	15·7

It will be seen that although a number of trees were found which bore flowers of both sexes in approximately equal proportions, there was clearly a tendency for trees to be predominantly male or female; and in each of the two years 45 per cent of the trees had less than 5 per cent of female flower and could therefore have produced very little fruit. During the last flowering season the 123 trees in Plot 1 above were examined every few days and the percentage of male and female flowers borne by each tree was estimated. This estimate was only an approximate one, as the time available for the work did not permit of any accurate flower counts being made. (It is doubtful if such flower counts would ever be practicable on any scale as trees of this age produce anything up to 40,000 flowers each.) No strict accuracy is therefore claimed for the figures in Table V, but within the broad classification given they will not be far out.

TABLE V

CLASSIFICATION OF 123 TREES AT ZOMBA BY PERCENTAGE OF FEMALE FLOWERS (1939)

Percentage of female flowers	Number of trees	Percentage of trees	Mean yield per tree, 1940, lb. dry seed
Per cent		*Per cent*	
0 ..	4	3·2	0
0–5 ..	44	35·7	2·6
5–30 ..	2	1·6	12·7
30–70 ..	9	7·3	23·9
70–95 ..	31	25·2	20·1
95–100 ..	33	27·0	22·2

These figures again demonstrate the tendency for trees to be predominantly male or female and show that 38.9 per cent of the trees (48 trees) had less than 5 per cent of female flowers. The effect of the high proportion of male flowers on yield is clearly seen from the last column. The mean yields of the same 48 "male" trees over the last four years are shown in Table VI, where they are compared with the mean yields given by the whole 123 trees, by the 75 remaining trees, and by the ten best trees. These figures, together with the actual tree records, show that the 48 "male" trees have been consistently poor bearers over the whole period, while on the other hand some trees have given exceptionally high yields each year.

TABLE VI

YIELDS OF *Aleurites montana* TREES AT ZOMBA, LB. DRY SEED PER TREE

Year	1937	1938	1939	1940
Age—Years	5	6	7	8
Whole plot, 123 trees ..	5·2	9·5	11·0	13·8
48 trees with less than 5 per cent female blossom	0·5	1·2	2·0	2·3
75 remaining trees ..	8·2	14·6	16·8	20·1
10 best yielders ..	18·0	26·3	28·5	34·9

I have also noticed the occurrence of approximately 40 per cent of predominantly male trees in other *montana* plantations, both in Nyasaland (40 per cent and 41 per cent) and in Burma (42 per cent), and there seems little doubt that it is common to all plantations of this species established from unselected seed. It has been suggested that these trees will undergo a change of sex as they grow older, and as no information is available from mature plantations it is impossible to say with certainty that they will not do so. Five of the 48 "male" trees at Zomba certainly bore considerably more fruit this year than ever before, which may indicate an increase in the percentage of female flower. The remainder, however, although now in their ninth year, so far show no evidence of any change in sex, and the slight increase in amount of fruit borne each year is easily accounted for by the normal increase in size of the trees. It has also been claimed, in Indo-China [2], that even if the proportion of females is an hereditary factor, it is equally influenced by climate and soil; but the remarkably constant proportion of males found in plots in Indo-China, Burma and Nyasaland seems to suggest that these environmental factors play a minor part. Further investigations are required on these points, but in any case it is clearly most undesirable in a commercial plantation to have 40 per cent of trees which yield practically nothing for the

first nine or ten years, even if they are likely to improve later.

It is evident that a great improvement in yields per acre could be obtained if plantations could be established with selected and vegetatively propagated material in order to eliminate this considerable proportion of low yielders, or if the "male" trees in existing plantations could be converted by some form of top working with scions from good yielders. Quite apart from the problem of the "male" trees, there is obviously considerable scope for selection amongst the remaining 60 per cent or so of the trees, since these exhibit a wide variation in cropping capacity. The budding of scions from selected mother trees on to seedling stocks is likely to be the most useful method of effecting improvement at first, and small-scale trials have already shown that budding presents no difficulties, but the subsequent performance of the budded plants is as yet entirely untested. It is hoped to start further experiments on a much larger scale in the near future.

The yield variation between individual trees of *Aleurites fordii*, although considerable, is not as pronounced as it is with *Aleurites montana*. Some account of yield variation in *fordii* has already been published [3]. In Nyasaland there is no evidence of any appreciable proportion of the trees being unprofitable on account of being predominantly male. The *fordii* inflorescence normally contains flowers of both sexes, and trees bearing flowers of one sex only are either non-existent or very rare. Although, however, the problem of "male" trees does not arise with this species, yield variation is considerable, and there is therefore every likelihood that yields can be improved by selection and vegetative propagation.

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THE COMPARATIVE DIGESTIVE POWERS OF ZEBU AND HIGH-GRADE EUROPEAN CATTLE

The problem of developing high-producing cattle in the tropics has claimed the attention of many workers. Existing types of local cattle are too slow maturing and insufficiently productive (especially as dairy animals) for European settlers, and efforts have therefore been made to get more economical stock by crossing local cows with bulls of recognized European breeds. This policy has resulted in half-bred animals which are superior to their dams, but subsequent top-crossing with European sires has not continued this improvement. Instead, as the progeny of half-bred cows are graded nearer to the European breed, an increasing number of constitutional failures occur, and many animals possessing too high an admixture of European blood in their ancestry are inferior economically to the unimproved native stock.

Efforts are now being made in many countries to determine what environmental or genetical factors are responsible for this failure of high-grade stock. Nutrition is one of the factors considered as possibly contributing to this unsatisfactory condition, but it is not the only factor involved, for previous work has shown that the retardation of growth in young high-grade stock is caused by factors other than nutrition. A number of publications, however, indicate that the nutritional standards for European cattle are not suitable for zebus and suggest that there are differences in the digestive powers of the two types.

Since no actual direct comparisons of the digestive powers of zebu and grade European cattle were available, experiments on the subject have been carried out at Mpwapwa by Dr. M. H. French (*J. Agr. Sci.*, Vol. 30, pp. 503-510, 1940). Working with three different groups, each of two zebu and two zebu x Ayrshire grade oxen, and ten typical East African feeding stuffs, he found no significant difference between the average digestibility coefficients recorded with the zebu and the grade oxen. Moreover, for all practical rationing purposes, the starch equivalent and digestible protein values are not significantly different for the two types of oxen. Some of the zebu x Ayrshire cattle were three-quarters and others seven-eighths Ayrshire, but the higher grading to the European breed apparently did not affect the digestive powers.

REVIEWS

A Visit to the United States of America to Study Soil Conservation, by A. C. Maher; Govt. Printer, Nairobi, 1940; pp. 81, Sh. 1.

This report, which has been described by Dr. Bennett, Chief of the Soil Conservation Service, United States Department of Agriculture, as "one of the most accurate and comprehensive accounts of our work ever written by a foreign visitor," gives an account of observations and deductions made on a tour of some 16,000 miles through the U.S.A. to study soil conservation.

Various areas in the United States are dealt with in detail, showing the problems involved and methods used. Many of these are applicable to East African conditions and must be studied in deail.

The report, in stressing the broadness of the problem of soil conservation service, proceeds, "The Soil Conservation Service has become conscious that soil erosion is not exclusively an engineering or an agronomic matter but a land utilization and conservation problem to which all workers must contribute their special talents and training to achieve a final and common triumph." Dr. A. J. Pieters, of the Bureau of Plant Industry, is quoted as stressing the importance of paying attention, "as a guide, to the cultural practices of successful and experienced farmers in the neighbourhood." In East Africa this would also apply to the study of the better native customs of agriculture and seasonal grazing, many of which have been lost or abandoned owing to changes in land tenure or replacement by unsuitable European methods.

The difficulties of co-operative agreements with farmers for land utilization are dealt with and will serve as a guide and warning in any schemes developed in the future. The problem of stock reduction and control in the Indian reserves in the United States is discussed and it is very apparent how important the method of approach is in dealing with any primitive people; also the necessity for consistency and definiteness in the policy pursued by any Government as regards land utilization and especially limitation of stock.

The value of experimental stations to carry out work and prove methods of soil conservation is shown and details of experiments are given for many stations. Such stations are purely experimental and provide the data on which demonstration areas and co-operative agreements can be worked on a practical economic basis. Much of their experimental work proves certain engineering, agronomic and animal husbandry methods to be unsuitable or uneconomic and proves others to be satisfactory for use in actual farming, so saving the individual from wasting time and money on practices already proved wrong.

United States settlement and re-settlement policies are dealt with—a problem of great importance in Kenya, especially as regards the control of land utilization in the areas concerned, as without strict control the land is destroyed by malpractices in a very few years and the people will have to be resettled again or allowed to die out.

The summary of the causes of land deterioration in the United States is directly applicable to many parts of East Africa, both European and native; land exploitation for tax or boom prices for cash crops, agricultural methods, animal husbandry methods, water diversion by roads and railways, etc., and density of population are cited.

In examining the position in Kenya the report points out the need for real study of the problems of correct land utilization in both European and native areas; also of land tenure in both areas, especially where conditions are quite unsuited to small holdings or individual ownership, or are only suited to seasonal grazing of a limited number of stock and additional land may be required to make this possible.

Many constructive suggestions are made which require study for the future. Such suggestions as the formation of Civilian Conservation Corps require careful consideration to make sure they could be economically employed where work is seasonal and whether other work could be found in off seasons; also their effect on landowners, who might expect everything to be done by the Corps, as is their present tendency with regard to any Government-assisted work on their land.

In several places the report mentions the problem of density of population (with 300 up to 1,500 per square mile) and its result in the crowding of people on to land unsuitable for cultivation, or where holdings are too small, with the result that the land is doomed, especially where measures that might enable steep land to be used safely are uneconomic. The seriousness of this problem in many Kenya areas must not be overlooked. In any country the land when properly worked can only carry a certain number of stock and a balanced area of cultivation, grassland, tree, and other crops;

the amount depends on local conditions, soil conservation measures required, topography, climate, soil type, value of the crops suited to the area and markets. It is only by keeping this proper balance (proper land utilization) that the fertility of the land can be maintained or improved. The agricultural population that the area can carry safely, without destroying the balance, depends on the standard of living of the people, whether they be European or native peoples; the agricultural population being adjusted so that they can maintain a reasonable standard of living suited to their needs and health, and, at the same time, maintain the fertility of the land they occupy.

It is only when the agricultural population is in the proper ratio to the safe production capacity of the land that additional population can be employed on secondary trades and industries. In a purely agricultural community, if the population exceeds the safe productive capacity of the land, the land and people are destroyed. A population based on mining or other industries that can afford to import food is not dependent on maintaining the fertility of the land in their particular area. At the present time Kenya cannot be said to be in this condition.

The report urges the necessity of establishing secondary industries to absorb surplus workers from agricultural lands, but it must be remembered that wages for secondary industries must be such that the worker can support his family away from the land and not have to depend on his family growing food in any area where they unbalance land utilization. The value of education is also stressed.

The report will be of interest and value to all who have the future of Kenya at heart, whether they be administrative or departmental officers, farmers or business men; and even to those who only think of "to-day" when they realize that "the days of their job are numbered if the land is destroyed".

R.O.B.

AGRICULTURE, HEALTH AND NUTRITION IN TESO, UGANDA: 1. Interim Report of the Agricultural Survey Committee; 2, Report of the Teso Informal Committee, 1937; pp. 36, 1/-. Nutrition Report No. 1, An Investigation into Health and Agriculture in Teso, Uganda, by M. E. de Courcy-Ireland, H. R. Hosking and L. J. A. Loewenthal, 1937, pp. 28, 1/-. Nutrition Report No. 2, Teso: Abstract of a Further Survey of Health in Relation to Agriculture in Teso, Uganda, by L. J. A. Loewenthal, 1939, pp. 35; all published by the Government Printer, Entebbe.

In 1937 the Report of the Teso Informal Committee was published "by direction of His Excellency the Governor to call attention to the need for investigating agricultural conditions in Uganda." The Committee's terms of reference were circumscribed and related only to the questions of setting aside permanent forest land, of grass and bush fires, and of planting resting land with trees and grass; but the members of the Committee refused to be confined within such narrow bounds, and before the report ends they have touched on matters which, directly or indirectly, must affect almost every aspect of human activity in Teso.

Their recommendations are comprehensive. Besides those dealing with their terms of reference they make suggestions regarding new water supplies, additional staff, agricultural education, cotton planting, currency reform, purchases of imported goods, cattle auctions, the reorganization of labour, and a very far-reaching scheme for controlling the agricultural practices and land rights of the people. This last, of course, involves the whole social organization of the tribe.

But let it be said at once that they have not ventured unnecessarily into other fields. On the contrary, they have done so because in peasant society it is impossible to isolate one or two problems and study them *in vacuo*. If only that fact were more widely appreciated, if it were realized that an African tribe can only progress properly along a broad front and not disjointedly in isolated sectors labelled "Political," "Agricultural," "Medical," "Veterinary," or whatever it may be; there would be fewer mistakes, a sound, well-balanced modern social order would evolve in a far shorter period of time than is otherwise possible, and much tension and maladjustment would be avoided.

The report also recommends "that a Standing Committee be appointed to control such work and experiments as may be approved by Government," implying very wisely the necessity of a great deal of research before the Informal Committee's recommendations can safely be put into practice on a large scale.

The question of food production is quite rightly given first place in such research work, and the Agricultural Survey Committee has since published two nutrition reports, in 1937 and 1939 respectively.

Report No. 1 is an attempt to correlate "nutritional health," to use the authors' own expression, "with certain agricultural and economic factors". It opens with a very brief (4½ pages) description of Teso agriculture, after which de Courcy-Ireland and Hosking leave Dr. Loewenthal to it. Dr. Loewenthal is an eager searcher after truth. He obviously intends to get to the bottom of this nutrition business, and brings every weapon in his diversified intellectual armoury to bear on the problem. One of his main concerns appears to have been to evolve an order by which to express as a single figure the "nutritional health" of the people he observes, thus making possible the statistical correlation of this rather intangible quality with economic factors such as acreages, yields, population densities, and so on—an extremely difficult task in which he has probably been no more, and no less, successful than most others who have attempted the same thing.

His Health Index is based on six signs: (*a*) leg ulcer or scar, not due to yaws or ecthyma, in males and children, (*b*) dental caries in males and children, (*c*) phrynoderma, (*d*) xerophthalmia, (*e*) angular stomatitis, (*f*) anæmia.

Unfortunately, the relationship of ulcers to nutrition is extremely obscure, and though one probably exists, very little is definitely known about it yet. Dental caries is, of course, associated with calcium metabolism, phrynoderma and xerophthalmia with vitamin A deficiency, and angular stomatitis with a deficiency of nicotinic acid and possibly other substances. There are many causes of anæmia, and in his later work Dr. Loewenthal discards this sign. It will be generally admitted that an index based solely on those few signs can never adequately express the health, or even the nutritional state, of a family. It can never be more than half the story, for it overweights some parts (e.g. A deficiency) and ignores a number of very important factors such as calorie intake, the supply of adequate protein, minerals (other than calcium), and vitamins B_1 and C.

In Report No. 2 the Health Index is again to the fore and, together with the available economic data, is subjected to a searching mathematical analysis which the average reader will find tedious, if he understands it at all. For page after page this mathematical wrestling match proceeds, Dr. Loewenthal winning every round, and one is not surprised to find that by page 33 he has reduced his opponent, the problem of nutrition in Teso, to its lowest terms, making himself master of the ring and announcing his victory to his audience in a few short words (para. 48).

His conclusions are:—

(1) That leg ulcer is practically unknown in those parts of Teso where fish is eaten.
(2) No connexion could be found between the incidence of nutritional disease and anæmia.
(3) "Cases of angular stomatitis were seen for the first time in Teso."
(4) There are significant correlations between the acreage per consumer of certain crops and nutritional health, and also between the ratio of consumers to working units.
(5) Malnutrition increases as soil fertility decreases.

The last two, the result of the pages of arduous mathematics, boil down to the fact that the health of the Teso, like that of any other people, depends on the food supply being adequate in both quantity and quality, a conclusion whose novelty and profundity may seem to some readers scarcely proportionate to an intellectual struggle of such intensity. But be that as it may, gratitude is due to those concerned in these publications for having once again stressed the vital and intimate relationship which exists between man's environment, the way he makes use of it, and the standard of health and well-being he may expect to enjoy. A.T.C.

SCIENCE IN WAR

(*Penguin Special*, 140 pp., 1940)

This book was planned, written and printed in the space of one month to express "the anxiety and the dissatisfaction" a group of distinguished British scientists felt at "the half-hearted use of science in our war effort". Their criticism is essentially constructive: the theme on which they insist is the urgent practical need for "effective utilization of scientific thought, scientific advice and scientific personnel". Whether we like it or not, our society is based on technology; even more completely this war is one of technology; to attempt to wage it without the fullest aid science can give is, at the lowest, to ignore all the best possibilities of offence and defence; and the book sketches in some detail what weapons and what support science offers us now for the taking.

A NOTE ON WHEAT CULTIVATION IN TORO, UGANDA

By R. K. Kerkham, B.A., Dip. Agric. (Cantab.), A.I.C.T.A., Department of Agriculture, Uganda

Wheat is now grown along the north-east slopes of Ruwenzori, between elevations of 6,000 and 8,000 feet. The acreage sown during the past few years has been about 1,000. It is grown exclusively by the Bakonju, a primitive Bantu hill tribe.

Historical

The exact history of the introduction of wheat to Toro is not known precisely, but introductions of seed wheat were brought up by both the White Fathers Mission and the District Commissioner shortly before the outbreak of the Great War. Until 1930, most of the wheat grown was sold to the missions for sacramental purposes, and to other small mills where it was ground for sale locally. Since 1930 there has been an increasing, though small, export of wheat from Toro to Kampala, Eldoret and Kisumu for milling in a mixture with Kenya-grown wheat.

Varieties

Numerous introductions of Kenya wheats have been made, but the only variety which has stood up to rust attack is a Durum type, which was presumably introduced by one of the White Fathers from Italy. This variety is now grown exclusively. It is an awned flinty wheat, which gives a fair yield, but does not produce a satisfactory bread flour without admixture with hard wheats. Of recent introductions from Kenya the only variety which shows promise is Kenya Governor. It must, however, be realized that most recent introductions have been tried at the lower elevations, where the local Durum type also suffers from rust, and that hard wheats have not been given a fair trial at the higher elevations. Most of the trials made in the early days, and by the Agricultural Department in recent years at Isigomi and Kyembogo Farms, were designed to find a wheat which will give a fair yield at elevations of 4,500 to 5,500 feet. Occasionally these plots have given fair yields, but no variety so far tried can be considered sufficiently rust-resistant to make wheat-growing an economic proposition at elevations of less than 6,000 feet.

Method of cultivation

Slopes on the plots where wheat is grown are invariably very steep. In one village where a survey was recently carried out the minimum slope found was one of 14 degrees and the maximum 49 degrees. The land is cleared from forest, sown to beans or English potatoes, and then wheat is broadcast in the "stubble" without previous cultivation. When the wheat has germinated the weeds are slashed and left to dry on the plot. After this weeding the wheat crop is not again cultivated. At harvest time the ears are cut with a small knife, hung up to dry on a frame rather like the frames used for drying simsim in most parts of Uganda, and threshed with sticks in the house compound. When wheat cultivation has been started in a plot it is continued until the plot is exhausted, which is usually four to six years. Two crops are sown each year. Again there is the minimum of cultivation; the second crop is sown in the stubble of the first without cultivation, and the only form of cultivation is one weeding per crop. It will be seen that this method of growing the crop is admirably adapted to reduce erosion to a minimum, and in fact very few signs of erosion are to be seen in wheat plots. Yields under this system are naturally low, perhaps about 1,000 lb. per acre in the first year, going down to 200 to 300 lb. per acre in the third or fourth year, but the amount of work per acre is also very small.

In the past the Bakonju were accustomed to cut down a new plot of forest when their old plots became exhausted. This process has now been stopped by the demarcation of a Crown forest along the top of cultivation at an elevation of 7,000 to 8,000 feet. Though small areas of forest have been left below this line, the Bakonju will now have to adopt a rotational system of resting their land or reduce their wheat acreage.

Marketing and utilization

The Bakonju will not grow wheat for sale unless they can get a price of about five cents per lb. In recent years this has meant that wheat is only grown at places within 50 miles of Fort Portal, as at more remote places transport charges become excessive. Though wheat is increasingly being used as a food—in fact, it is the main food crop in several villages—the crop has so far not been grown in areas where it would be a food crop only. It is estimated that the total crop in 1939 was about 200 tons, of which 110 tons were sold and 90 tons used for food or seed.

The crop is sold to local traders at daily markets, which are arranged by tender, markets being held whenever the local chief advises that at least five tons are available. Careful supervision is necessary at these markets to ensure that unripe samples, and samples containing excessive quantities of gravel and dirt, are rejected.

SUMMARY

Wheat has become an important economic and food crop in certain villages at 6,000 to 8,000 feet within fifty miles of Fort Portal. Owing to high transport costs the amount offered for sale is not likely to increase greatly, though it is not unlikely that the area grown for home consumption will continue to increase.

ARTIFICIAL CONTROL OF HELOPELTIS

The *Helopeltis* bug causes damage to a wide range of host plants, the most important in East Africa being cotton and tea. Where cacao and cinchona are grown they also are attacked. In the nursery, seedlings of avocado, mango, guava, and kapok, among others, are severely affected. As described by Harris (this Journal, Vol. 2, p. 387), the injury consists of two main types: —

(*a*) *On the foliage.*—Numerous angular spots appear, first of all black, later becoming brown and more or less transparent as they dry out. Leaves severely attacked when young crumple, and the plant develops a bunching growth. Superficially these spots resemble those caused by bacteria—for example, angular leaf-spot in cotton—but with the important difference that fresh *Helopeltis* spots are never water-soaked.

(*b*) *On the stems and branches.*—First discoloured patches appear, which after a short time dry out and form rough, corky lesions. These, if large, split and form cankerlike growths as the stem becomes woody. They are to be distinguished from bacterial lesions by the fact that, until they begin to dry out, they only affect the outer layers of the stem.

It does not need a large population for conspicuous damage. It has recently been found at Amani that severe injury was caused to cinchona when the average number of *Helopeltis* present did not exceed one adult and at most two nymphs per tree. This became more understandable when it was found in the laboratory that the daily number of lesions produced by a single third-instar nymph varied between 60 and 140, with an average of 85.

In experimental work with *Helopeltis*, which is being published elsewhere, Kirkpatrick noticed that the bugs kept in the laboratory rapidly found and fed on sugar solution. This suggested the possibility that poison-bait might be effective. For the present purpose a strength of 1 oz. of sodium arsenite and 5 lb. of sugar to 4 gallons of water was the most satisfactory. When cinchona foliage sprayed with this solution was made accessible to *Helopeltis* in the laboratory, over 80 per cent of the bugs were dead in twenty-four hours and all the rest in forty-eight. With only ½ oz. of sodium arsenite per 4 gallons, the immediate effect was equally good, but after a single night's dewfall the poison lost its power. A solution containing 2 oz. of sodium arsenite scorched the leaves.

Owing to a seasonal shortage of *Helopeltis* and Mr. Kirkpatrick's departure to join the forces, the experiments could not be extended to the field. His preliminary results are, however, of interest for those concerned in the control of this troublesome insect. The indications are that the best results consistent with economy of bait would be obtained by the use of a sprayer that delivered the fluid on to the foliage in the form of small droplets rather than as a fine mist.

In Unyamwezi, natives boil sweet potatoes first, then peel and slice them, and dry them in the sun. The dry chips are semi-transparent, very palatable, and I have found them an acceptable "iron ration" on *safari*.

M. J. Fortie, in a letter to the Editor.

Good scientific work demands that the man of science should aim to be energetic, humble, both constructive and critical, neither sterile nor credulous, accustomed to think before he acts and to act upon his conclusions.

E. F. Caldin in *Nature*.

NOTES ON ANIMAL DISEASES

IX—THE POX GROUP OF DISEASES*

Compiled by the Department of Veterinary Services, Kenya

There exists amongst mammals and birds a group of closely related diseases which are characterized by the development, usually on the skin, of a lesion called a pox, or variola, a lesion which has been recognized since ancient times. In mammals it begins typically as a small red spot. Twenty-four hours later the upper layers of the skin in the centre of the spot thicken and, after a further day, a vesicle containing a drop of clear, yellowish, serous fluid develops. Later the surface of the vesicle becomes depressed and the contents cloudy. After several more days the contents of the vesicles dry and the swelling disappears from the skin. Eventually the scab drops off. This scab is very rich in the causal virus and is the vehicle by which the disease is spread.

The pox viruses are among the larger of the viruses that cause disease in animals. Although they can be made to pass through the pores of some of the coarser filters and are therefore correctly classed as filter-passers, there is strong evidence to suggest that the small objects, known as "elementary bodies", which are on the limits of visibility under the highest powers of the microscope, actually consist of virus. The viruses are very resistant to drying and infection is usually spread by fine particles of dried scab. The viruses cannot be cultivated on the ordinary lifeless media used for the cultivation of bacteria, but are easily propagated in the presence of appropriate living cells; for example, in tissue cultures and on the chorio-allantois of the developing chick embryo.

In the living animal the viruses multiply in cells of the skin and of the mouth, air-passages, brain and other tissues which originate from the embryonic ectoderm. In the cells inclusion bodies (Guarnieri bodies in vaccinia, etc., Bollinger bodies in fowl-pox) are formed, and these represent the sites of multiplication of the viruses.

It is probable that the pox diseases of mammals are caused by variants of one, and those of birds by variants of another, related virus. In East Africa, in addition to smallpox in man, sheep-pox (variola ovina), cow-pox (variola vaccinia) and camel-pox occur in mammals, and fowl-pox and turkey-pox in birds.

Sheep-pox

Of the group affecting domestic live stock, sheep-pox is the most important, and in other parts of the world is usually associated with heavy mortality in affected flocks, but in Kenya outbreaks of sheep-pox are usually mild and heavy mortality is never reported.

Susceptibility.—The disease is most frequently seen in woolled sheep, although native breeds of sheep and goats are sometimes affected. Young sheep are more susceptible than older sheep and the disease is usually most severe in lambs.

Natural infection.—Infection is introduced into a healthy flock by a sick sheep, by contact with contaminated skins, wool, or foodstuffs, or it may be carried on the hands or clothing of human beings who have been handling sick sheep. In dry weather, infection has been known to persist on pasture previously used by infected sheep for as long as two months.

Under natural conditions the virus is probably inhaled and passes from the lungs into the bloodstream. It is thus disseminated to its predilection sites on the skin and elsewhere.

Symptoms.—After an incubation period of approximately eight days, a typical pox eruption develops. In the early stages there is a temperature reaction and a discharge from the eyes and nose. A few days later round, red spots appear on the skin. The most frequent sites in sheep are on the nostrils and around the mouth, on the vulva and udder of females, on the prepuce and scrotum of males and on the inside of the thighs. The red spots develop into vesicles and scabs in the usual manner.

With the appearance of the skin eruption, general symptoms, if they have been present at all, become less marked. The animals appear bright and feed normally, although discharge from the eyes and nose usually continues. Often there is salivation. At the time of pustule formation, general symptoms again become more marked and the sheep are usually off their food; but when the scabs begin to dry recovery is usually rapid.

Post-mortem lesions.—The characteristic lesions are of course those found on the skin, and it is rare for diagnosis to present any

* The instalment of this series in the October number should have been numbered VIII not VII.

difficulty. In addition to the skin lesions, ulcerated pox lesions may be found in the mouth, pharynx, nose and windpipe. Hæmorrhages may be present in the mucous membranes of the air passages and in the stomach and intestines. In some cases the lungs are affected, the lesions in adult sheep consisting of small nodules which on section have a pale centre and an inflamed boundary region. In lambs adjacent nodules coalesce forming extensive patches of broncho-pneumonia—a lesion often confused with that of true suppurative broncho-pneumonia of lambs.

Course.—The usual duration from the appearance of the eruption until the scabs fall is from three to four weeks. During outbreaks the early cases occur at about fortnightly intervals. After about four to six weeks, cases occur in greater numbers and with much greater rapidity, and in a short time the whole flock is affected .

Prevention.—Preventive vaccination consists in the inoculation by scarification of a small area on the inside of the thigh with a mild strain of the virus. This inoculation causes the development of a typical eruption; but the eruption is usually localized to the small scarified area. The local attack of the disease results in a serviceable immunity.

Cow-pox

Cow-pox is a mild disease, the typical pox eruptions usually being restricted to the udder and teats of the cow. It is spread by milkers, on whose hands it produces local pox lesions. The observation by Jenner that cow-pox eruption on the hands of milkers produced immunity to smallpox led to the use of cow-pox virus (vaccinia) in the preventive inoculation against the more serious human disease. The word "vaccination," originally applied to this procedure, has since developed a wider meaning.

Cow-pox lesions may be treated by the application of astringent, antiseptic lotions or ointments.

Camel-pox

Camel-pox occurs mainly in young camels, and although the symptoms are severe, mortality is usually low.

The pox eruption, which usually develops on the lips, is preceded by swelling of the head, slight fever, loss of appetite, and constipation. According to Cross, when old animals are attacked, the swelling of the head may be so marked as to produce difficulty in swallowing.

Treatment consists in allowing green food, administering laxatives, and attending to the lesions. Weak antiseptic lotions should be applied during the early stages and antiseptic ointments when the scabs form.

Fowl-pox

Forms of fowl-pox have been recorded from a great variety of birds, both wild and domesticated. Strains of virus collected from one species may not be transferable to any but closely related species. Thus virus obtained from a hen can usually be inoculated to turkeys, but only very rarely to pigeons. Pigeon-pox inoculated to fowls produces a very mild disease, but when passaged through a number of fowls, the virulence of the virus becomes enhanced for fowls and diminished for pigeons.

It seems probable therefore that the viruses responsible for pox in different species of birds have a common origin and that by passage in any one species they have become peculiarly adapted to that species.

Although the viruses of mammalian poxes may be grown on the avian egg-membranes, these viruses will not produce lesions when inoculated on the skin of birds; neither will fowl-pox virus infect mammals.

The skin lesions of fowl-pox differ somewhat from those of the mammalian poxes. They begin as small nodules, about 1 mm. in diameter, greyish or pink in colour. They enlarge rapidly, remaining always firm and circumscribed. After about a week they look rather like warts and are about 5 mm. in diameter. Usually they are prominent, but flat forms are occasionally encountered. The larger nodules appear rough and grey or yellow-brown in colour. The summit may appear moist for a short time, but a solid, usually fleshy appearance of the nodule is more typical. From one to two weeks after the appearance of the nodule a zone of inflammation appears around the base and the area at the top begins to dry and shrink. A dark brown scab is thus produced, which eventually drops off. As in mammalian poxes, the scab is very rich in virus.

Birds susceptible.—Pox occurs in fowls, turkeys, pheasants, pigeons, waterfowl, and hawks, although as mentioned above a strain affecting one species is only transmissible to related species.

Symptoms.—The typical eruption appears after an incubation period of four to twelve days. Skin lesions are usually found on the parts devoid of feathers, the comb, wattles, ears, eyelids and angles of the beak. Occasionally, in addition, some of the less closely feathered parts are affected.

In many cases lesions appear on the mucous membrane of the mouth, and cloaca, and on the conjunctiva of the eyes. These lesions differ from those found on the skin. They consist of flat greyish-yellow spots which coalesce and form a raised, necrotic mass which increases in extent as the disease progresses. The cheesy-looking mass in the pharynx may become so extensive as to cause death by suffocation.

Outbreaks in which lesions are confined entirely, or almost entirely, to the mucous membranes are not uncommon, and form one of the types of fowl diphtheria or roup. Other clinically similar forms of roup are caused by various bacteria, by different viruses and even by lack of nutritional factors.

In addition to the appearance of specific lesions on the skin and mucous membranes, marked general symptoms occur in fowl-pox. These are lack of appetite, dulness, ruffling of the feathers and pallor of the comb and wattles. Diphtheritic lesions may interfere with breathing and cause whistling noises during inspiration. Swallowing may become painful. Egg-laying is usually suspended.

In birds that recover, improvement begins about the fourth or fifth week, but is slow.

Transmission.—Although the scabs from the lesions are rich in virus, infection does not spread easily from infected birds to healthy birds unless the skin of the latter is injured. In recent years, evidence has been forthcoming to show that under experimental conditions the disease can be conveyed from infected to healthy birds through the medium of mosquitoes. The fact that in natural outbreaks lesions are often confined to the exposed parts of the head, whereas, by inoculation, any part of the skin can be infected, supports the experimental evidence.

Mortality.—Mortality is not usually high except in young birds. Outbreaks of fowl-pox occurring in birds of from two to three months may result in very heavy losses. At this age birds are usually developing their first worm infestations, and no doubt the heavy parasitic burden makes it more difficult for them to overcome the fowl-pox infection.

Treatment.—A protective vaccine similar in principle to that used to prevent sheep-pox is usually employed. This consists of an emulsion of a mild virus which is applied by scarification to a small area on the leg. In Europe a strain of pigeon-pox virus is widely used, but tests at Kabete have shown that a better immunity results from the application of a local strain originally obtained from an outbreak in turkeys.

Local treatment of infected birds is of considerable value. The nodules may be dressed with an oily dressing until they soften and can be removed and burnt. The raw underlying surface should then be dressed with tincture of iodine or other antiseptic. Necrotic lesions in the mouth can be loosened by scraping with a pair of forceps and removed, the underlying sore being suitably dressed. Good feeding helps and quarantine measures may delay the spread of infection to other runs, at least until the occupants can be vaccinated.

Contagious pustular dermatitis of sheep

The virus of this disease is one of the larger viruses which multiplies exclusively in the skin and is very resistant to desiccation.

Animals susceptible.—Contagious pustular dermatitis, also called contagious pustular stomatitis, is a disease of sheep and goats. Outbreaks are most commonly observed in lambs.

Symptoms.—The onset of the disease is marked by inflammation of the mucous membrane of the lips. The lips swell and small vesicles develop. These become pustules and later ulcers. The lesions may be present on a small portion of the lip or the whole of the lips and the skin around the nostrils may be involved. In very severe cases the inside of the mouth, including the surface of the tongue, may be the site of necrotic ulcerating patches.

After the lapse of a few days the lesions on the skin of the lips either heal or develop into elevated warty growths which may persist for several weeks. These warty growths are very characteristic of the disease.

General symptoms are usually lacking, but in very severe outbreaks cases showing inflammation and discharge from the eyes and swelling of the throat may be found. When the lesions round the lips are very extensive there may be difficulty in feeding, but in general it is remarkable how little the lambs are affected.

In many outbreaks the lesions on the mouth of the lambs are associated with extensive ulceration and sores on the udders of a percentage of the ewes. The ewes may also be lame. Mortality in both lambs and ewes is usually low, and the disease is not often of great economic importance.

Outbreaks of the disease are occasionally reported in weaners, when lesions are usually confined to the legs in the region of the coronets.

Treatment.—Stockholm tar should be applied to the lesions. In severe cases a dose of Epsom salts may be given.

Differential diagnosis.—Contagious pustular dermatitis is liable to be confused with streptothricosis, a disease associated with the presence of a fungus and in which large pencils of hairs and later wart-like growths develop on the lips (and also on the ears, coronets, and under the tail). Whereas in contagious pustular stomatitis the disease runs its course in four to six weeks, the lamb then acquiring immunity, streptothricosis is a chronic disease occurring in sheep of all ages and rarely followed by any appreciable immunity. The fungus associated with streptothricosis does not commonly produce lesions when inoculated by scarification on the skin of sheep, although it can be transmitted by this method to calves and rabbits, and it would appear that some secondary factor, possibly nutritional, may be necessary for it to produce disease.

CORRESPONDENCE

The Agricultural Research Station,
Kawanda, Uganda,
20th July, 1940.

The Editor, East African Agricultural Journal.

Sir,

With reference to the note on digging-sticks on p. 342 of the East African Agricultural Journal, Vol. V (March, 1940), I can quote an instance in which digging-sticks are used in Uganda. This is amongst the Banyaruanda tribe in Bufumbira county of Kigezi district, in the Western Province. In the southern part of this county the soils are of volcanic origin, and many of the cultivated plots, although very fertile, are so encumbered with lava boulders and stones that digging with a hoe only results in blunting it. In these circumstances the people often use a digging-stick, which consists of a piece of wood with an elbow joint, such as is used for the local hoe handles. Instead of attaching a hoe blade, the end is merely sharpened and shod with a piece of iron which can be fitted by the tribal blacksmith.

G. B. MASEFIELD,
Agricultural Officer.

Dar es Salaam,
November, 1940.

The Editor, East African Agricultural Journal.

Sir,

I am glad to see in the October number of your Journal that at long last a start is being made with tackling the long overdue subject of Termites; and I am delighted with the prospects, foreshadowed in your editorial, when you refer to certain chemical functions of these insects in connexion with concentration of lime, as well as in Mr. Harris's introductory paragraph where he draws attention to their important position in the organic–inorganic cycle as breakers-up of vegetable matter and movers of soil; Mr. Wilkinson likewise hinting at these aspects.

I therefore sincerely hope that in succeeding instalments of the promised series of articles the widest possible scope will be given to the attitude which sees in the termite not so much a *destructor* but rather a *conservator* of Nature's harmonious equilibrium, a status reached by one of the most efficient adaptations to a grim environment that biological study is revealing to us. Surely, if the insects were mere destructors of vegetation neither trees nor grass could have survived the "attacks" of countless millions of destructive termite generations! Not only is the fact undeniable that plants and insects live, and always have lived, harmoniously side by side, but there is a great deal to be said in favour of the assumption that such harmony—or equilibrium—has been attained by some sort of subtle symbiosis, to study which should, clearly, be our main aim.

If we look at the context without the usual anthropocentric bias we shall probably find that the *real* destructor is *Man,* who is as yet far removed, certainly in the tropics, from successful adaptation to their very difficult environment; and if in his tentative endeavours to exploit the latter he renders life a little easier for what is, after all, a very small fraction of the termite communities, it seems hardly fair to blame the insect. It would appear more in conformity with *"homo's"* noble sub-title *"sapiens"* if by humble and careful research he were to find out the real functions of termite states with regard to the soil-water-vegetation complex, whereby he may, eventually, and for all we know, profit towards his own better adaptation infinitely more than by applying his much overrated mechanization and poison gases and what-not in a forlorn fight against the instincts and traditions of ages, without which—be it repeated—he would in all probability find no suitably prepared tropical soils from which to feed, let alone enrich, himself!

I remain, Sir, Yours faithfully,
C. GILLMAN.

NOTES ON LAND TENURE

II—EGYPT

By V. Liversage, B.Sc. (Lond.), M.S. (Wis.), N.D.A., Agricultural Economist, Kenya

General background

The portion of the country of Egypt which is exploited agriculturally is confined to a narrow strip on each side of the Nile from the boundary of the Sudan to near Cairo, and the fan-shaped delta north of Cairo. This area has from ancient times been irrigated by basin irrigation during the Nile flood, and the soil has been built up by successive annual deposits of silt. All but a small portion has now been converted to canal irrigation.

The irrigated area is under an intensive system of cultivation. The commonest rotation is one under which three crops are taken in two years, thus:—

March to September: *Sefi crops,* i.e. cotton.

November to May: *Shitwi* crops, i.e. wheat, *berseem* (=Egyptian clover (*Trifolium alexandrinum*), etc.

June to December: *Nili* crops, i.e. maize, rice.

An abrupt line separates the cultivated from the uncultivated land. The latter is in most places absolute desert. Hence live stock cannot obtain a portion of their sustenance from grazing upon "commons and wastes" as in most countries. Nor is the amount of waste land represented by canal banks, roadsides, etc., significant. Live stock must therefore subsist entirely on the produce of the arable land. In Egypt live stock are utilized in a more direct manner in connexion with the arable land than in India. As in India, much of the forage produced on the arable land is cut and carried off to feed the animals in the villages, the manure being used for fuel. During the *berseem* season, however, cattle and buffaloes are tethered on the *berseem* land and fed upon the cut forage. As day by day, a small portion of the crop is cut and fed to them, they are advanced in a line following the sickle, and thus the whole of the area receives a portion of their dung and urine. Small areas along the margins of fields, generally under the shade of a tree, are left for the tethering of animals, and the urine-soaked earth from these places is afterwards spread over the field.

The buffalo forms the chief part of the dairy stock of the country, and is used also for light work. The male calves not required for breeding purposes are fed for about a month and then sold for veal. Buffalo milk is either consumed in the liquid state or made into *semn* (ghee) or cheese. In the making of the former there are two processes in use:—

(*a*) The milk is placed in a goatskin, left for a day or two and then churned by shaking the skin with its contents. The butter is removed and heated in the ordinary way. The goatskin is sterilized by being heated in an oven.

(*b*) The milk is put in an earthenware vessel for the cream to rise. The cream is skimmed off and churned.

Sometimes a skim-milk cheese is produced by drying the curd which results from the souring of the milk used for ghee-making. Cheesemaking is also followed by small dairymen to whom it is an art handed down from their forefathers. They buy buffalo milk from neighbouring cattle-owners.

Land tenure

The land system of Egypt at the present day presents a good deal of variety. At the one extreme there are small peasant properties, in many cases insufficient to afford a subsistence to their owners, who rent additional portions from larger owners. At the other extreme there are large farms worked by their owners by means of hired labour. In between there are owners and tenants of every degree.

According to figures given by an official of the Credit Agricole d'Egypte, 70 per cent of the landowners own less than one feddan each, while some two-fifths of the total land area is in large properties of over 50 feddans each.

A large proportion of the land is not farmed by the owners, but is leased on various tenancy arrangements to working tenants. However, statistics show a great disparity between large and small units. One result is shown in the following figures of status of persons engaged in agriculture, taken from the population census of 1927:—

Employers and on own account: 1,030,916
Employees: 2,420,705

It is not known to the writer how the large number of small owners who eke out the income from their land by working as hired labourers on large farms were classified.

The modes of tenure in existence are as follows:—

(1) *Owner-farming.*—The small owner cultivates his land with the assistance of the members of his family. Owner-farming is also followed by a certain number of large proprietors who cultivate cotton by means of hired labour but let the land to tenants for cultivation of the other crops in the rotation. The same system is followed with lands newly brought under cultivation, where the investment of large capital is necessary and the return is low for some years.

This is the dominant system in Egypt. According to the Agricultural Census of 1927, the following numbers of holdings and areas of land in farms were owned and leased respectively:—

	No.	*Area.*
Owned	998,390	5,805,395
Leased	316,715	1,635,301
Total ..	1,213,915	7,440,696

The difference between the number returned as owned and leased, and the total, is explained as due to farms partly owned and partly leased. The difference amounts to 101,190, and by itself it hardly seems sufficient to account for the statement that a large number of small proprietors are obliged to eke out the subsistence afforded by their holdings by taking additional areas on lease.

(2) *Cash Tenancy.*—This system is employed largely in the exploitation of large and medium-sized properties. Leases are short, usually for one year only, but sometimes for two or three years. Rents are competitive, and thus there is a more or less continuous land market and current rental values indicate the rise and fall of agricultural prosperity.

In some cases intermediaries take comparatively large areas on lease for longer periods and sublet to small cultivators.

The land is protected from impoverishment by the strict enforcement of a defined rotation. The conditions of tenure are laid down in a written tenancy agreement which is drawn up and signed by both parties.

Land is not necessarily leased in complete holdings. Sometimes, as indicated above, the landowner himself cultivates the cotton for his own profit. The land falling under the other crops in the rotation, such as maize, wheat, *berseem,* may then be leased to small cultivators, not necessarily as a whole, but often piecemeal.

(3) *Share Tenancy.*—This method is comparatively uncommon, but is employed sometimes in the less fertile parts, or in areas where the population is less dense. It became more common after the onset of the depression. The terms vary according to the contribution made by each party to the costs of production. Where the produce is shared in equal parts between landlord and tenant, the latter usually provides for all the costs except the land and land tax. At the other extreme, the landowner may provide everything except manual labour, the tenant receiving one-fifth of the produce in return for his contribution of manual labour.

The share method is sometimes applied even to live stock. A buffalo calf, for instance, may be purchased by the landowner and handed over to the tenant on condition that it is sold, say after its second calf, half the increase both in the form of calves and of sale value going to each partner.

It is said that land is sometimes leased in consideration of a produce rent; as, for instance, a given quantity of cotton.

Mohammedan succession law prevails, and thus it is held that the tendency must be for holdings to decrease in size. Daughters inherit half shares and these presumably pass to their husbands on marriage. Unlike the case in the Sudan, it is said to be uncommon for shares to be left in an undivided form on succession.

Fragmentation of right-holdings and of cultivation holdings is present, though probably not to the same extent as in India. It is not customary to divide each separate plot among the heirs on succession, but, having regard to the commercial value of the land, an arrangement is come to which will minimize the degree of fragmentation involved. No statistics or village surveys are available, however, to indicate the actual extent of fragmentation. Nor is it held to be particularly deleterious, for right-holders and cultivators endeavour to keep their land concentrated within the confines of a single village; the villages are fairly close together, and there is therefore comparatively little loss of time in travelling from one plot to another. Human labour is comparatively important and animal draught unimportant in field work, so that the disadvantage of small scattered plots in this respect is minimized. Little land appears to be lost in unnecessary boundaries. Piecemeal purchase and sale operates both ways, though, as the peasant who has accumulated some cash seizes the first opportunity of investing it in land, the general tendency would seem to be in the direction of fragmentation.

Owing to the inherent fertility of the land and the severe pressure of population upon the available area, land has acquired a very high value. Values of £80 to £100 per feddan are said to be usual, even at the present time, while much higher prices have been paid in the past. Unfortunately, no statistics of land values were obtained. The value of land is estimated for taxation purposes, but only at intervals of thirty years. There is a continuous market for land in the shape of yearly tenancies, which are on a competitive basis, but I was unable to gather any facts as to present-day rents or their variation in the past.

An officer of the Statistical Department estimated the average rental value per feddan as £E5.30 in 1930-31 and £E4.53 in 1931-32, and stated that the average rent per feddan in 1895-96 was £E3.60. These high rents must, of course, be judged against the background of the very high productivity of land in the Nile Valley and the cost of irrigation.

Where a large proportion of the land is retained in large estates and the population is dense it is only natural that competition for land will keep values as high as conditions will allow. In other words, nearly all the return is secured by the landowner. The tenant or small owner lives on an extremely low standard.

Indebtedness

It is a paradox of the situation that one effect of the low standard of living should be to induce the peasant to assume burdens which add to his distressed condition. The readiest means of betterment appears to be to become a landowner or to add to his small property. To this end he loses no opportunity of purchasing any piece of land which may come into the market. To do this he has recourse to the moneylender, and instead of a competitive rent he pays an extortionate rate of interest to the moneylender.

So far as I am aware, there are no actual figures indicating the extent of indebtedness among agriculturists. That the situation was serious in the past may be inferred from the enactment of the "Five Feddan Law" in 1911. The purport of this act was to protect the small owner against the sequestration of his property, including his last five feddans of land, his house, two oxen and his implements of husbandry.

Reference has been made to the land hunger of the peasant and his readiness to make use of the moneylender in acquiring any land which may come on to the market in the vicinity. The effects disastrously familiar in other parts of the world are to be expected. He bid up the price of land in good times and in periods of low prices could not keep up the payments required. Further, the *fellah* is ignorant and improvident; any cash surplus remaining from the operations of one year was either put into land or spent otherwise, and resort was had to the moneylender for money to carry on with until the next crop was ready. This the village moneylender advanced on the understanding that the crop was to be sold through him.

How far the five-feddan law achieved the effect intended is a subject on which opinions differ and precise facts are non-existent. Kipling, in his *Egypt of the Magicians* (1913), said that there were many ways of evading the law known to the authorities and others they had not thought of. There would be arrangements, accommodations, adjustments, until it was all the same as before. As to protecting the improvident *fellah* against himself, "That, alas, is the one enemy against which no law can protect any son of Adam."

The majority of those whose opinions were solicited agreed that this was what had in fact happened; that means had been found to render the Act a dead letter, for example by means of bogus sales. Others held the opinion that the Act had in some degree expelled Greek moneylenders from the villages.

The authorities appear to agree that one effect of the Act has been to restrict the credit of the *fellah*, and this causes them some uneasiness, in the fear that cultivation may be curtailed from lack of funds. This apparently happened with the onset of the recent depression, and it is said that 200,000 feddans went uncultivated in 1930-31. Hence, it appears necessary to ensure the adequate provision of legitimate credit and at the same time to guard against abuse of credit by over-issue. The distinction is, in the main, one between seasonal credit for productive purposes and other credit for land purchase or for non-agricultural purposes.

Both forms of credit are now supplied by semi-government agencies.

For the supply of credit an Agricultural Bank had been created in 1902. The bank issued short-term loans on note of hand and long-term loans on land mortgage. After the enactment of the five-feddan law, the bank's operations contracted immediately to very small proportions.

With the high prices of agricultural produce, particularly cotton, during and after the war, the question of agricultural credit faded into

the background, until the sudden contraction of credit with the onset of the world depression brought it again to the fore.

In 1931 the Credit Agricole d'Egypt was created, with a capital of £1,000,000, subscribed in equal parts by Government and the leading banks. The Government guaranteed a dividend of 5 per cent and authorized advances to the organization of up to £E6,000,000. The Credit Agricole makes short-term advances for cultivation purposes, either through co-operative societies or direct to cultivators. It also supplies actual materials, such as seed and manures, on a short-term basis.

In its short-term business the Credit Agricole is protected by two important legislative enactments. Firstly, the five-feddan law is abrogated so far as its operations are concerned. Secondly, it has been given the right of claiming administrative collection of sums due or of seizure of crops in respect of which it has advanced loans. Hence its powers are fairly complete, and arrears are not large. In practice, instead of crops being seized in settlement of loans, they are usually handed over to the control of the Administration. The cultivator arranges for their sale in the usual way, sale being subject to the approval of the taxation officer, and on completion the amount due is recouped out of the proceeds.

The Credit Agricole also issues intermediate-term credit for the purchase of cattle and agricultural machinery. Such loans are advanced either to co-operative societies or to individuals To co-operative societies the maximum term is five years. To individuals the maximum term is ten years, but in this case a mortgage on the land is taken as security, while no such security is demanded in the case of co-operative societies. Loans are also issued for the permanent improvement of land, for periods up to 20 years, guaranteed by "inscriptions"—first or second charges on the land.

Operated by the same personnel as the Credit Agricole, but on a separate financial standing, is the Hypothecaire Agricole, which supplies the long-term credit needs of the landowner on a mortgage basis. This was created in 1932 to meet a situation in which the ordinary banks and other creditors were in a position to commence expropriation proceedings on a large scale. The funds are provided directly by Government.

A large volume of agricultural mortgages, previous to the creation of the Hypothecaire Agricole, was held by the Agricultural Bank of Egypt, the Credit Foncier Egyptien, and the Mortgage Company of Egypt. The debts of the Agricultural Bank were transferred to the Hypothecaire Agricole, and the Bank wound up. An agreement was made with the other banks whereby the mortgages held were consolidated and payment spread over a period of 30 years, at a reduced rate of interest. Later, the mortgages held by the Mortgage Company of Egypt Ltd. were taken over by the Credit Agricole.

COLLECTING

From early childhood the jackdaw-complex is deeply engrained in most of us; and although specimen collecting may become a vice, it shares that risk with all other virtues. So long as mere miserly acquisitiveness is avoided, the arrangement and study of collected material can revive memories of past thrills and prolong the joys of field work . . . Collection involves dissociation of the specimen from its natural environment; in the majority of cases that environment is one of the most informative features of the specimen. It cannot be brought away in substance, but it should always be recorded in writing with all possible detail. Paradoxical though it sounds, it is nevertheless true that a collection of specimens without adequate labels is less useful than a collection of labels without specimens. Every particular of the circumstances attending the collection of the specimen should be written down at the actual time and place—memories get blurred at the end of a day. Even details that seem irrelevant should be noted; wider experience may show that just such points had the greatest significance.

If all the material that clutters up our museums had been collected in accordance with that simple principle, its value for scientific research would have been enhanced a thousandfold; the charnel-house would have been a biographical library. One battered fragment with a history is worth a score of "plums" without a label; for there is more satisfaction in scientific circles over one poor specimen with particulars attached than over ninety-and-nine perfect examples that have no such accompaniment.

Prof. H. L. Hawkins, in *The Advancement of Science*, Vol. 1, No. 2, p. 316, Jan., 1940.

PRINCIPLES GOVERNING THE CONSTRUCTION OF POULTRY HOUSES AND RUNS

By M. H. French, M.A., Ph.D., Dip. Agric. (Cantab.), Veterinary Laboratory, Mpwapwa, Tanganyika Territory

Proper housing enables control to be kept on the flock, tends to encourage egg production, and, because it reduces the food which has to be utilized in maintaining body temperatures during storms and cold spells, helps to reduce the costs of production. The success of a poultry house depends primarily upon the degree of comfort it affords to the birds. Briefly, it can be said that a good type of house will furnish its occupants with permanent protection from dampness, draughts, wind, extremes of temperature, dirt, vermin, and other causes of discomfort and disease, as well as from their larger enemies. At the same time it allows the birds to get adequate air and sunlight.

The site of the house and run

If the district is undulating the poultry house must be sited on the slope that gets the most sun. If it is built in hollows, drainage may be difficult and morning mists may hang around the pens so that the birds are chilled. Well-drained land should be chosen, preferably where trees provide shade for the birds in the heat of the day. This is most important in East Africa, because birds, having no sweat glands to keep them cool, need shelter from the mid-day sun, and the longer they can spend outside their house the smaller the house needs to be.

The location of the houses must also fit in with the general lay-out of the other farm buildings and be easy of access, so that they can be visited frequently. Birds need water constantly in front of them, and if the pens can be erected near an existing water supply much extra labour can be saved.

The requirements of a good house

(1) *Dryness.*—The house must be stormproof and dry, because there is no surer way of reducing profits than by forcing the hens to roost or live in damp surroundings. Dampness also encourages the growth of disease-producing organisms, and the maintenance of a dry house is one of the first steps in checking the development of disease.

(2) *Adequate ventilation.*—During normal respiration moisture and carbon dioxide are given off; adequate ventilation is therefore necessary to prevent the air in the house becoming so laden with these products that the birds are harmed. The droppings also give off odours and moisture which need removing by the intake of fresh clean air. Whilst too much ventilation can hardly be given, draughts are exceedingly dangerous and, by chilling the birds when they are roosting, may lead to colds and roup. Each bird requires 9 to 10 cubic feet of space in the poultry house.

(3) *Moderate temperature.*—The inside temperature of the house should not drop too low during winter nights but should remain low during the daytime in the hot season. Ample circulation of air and a shady tree do much to maintain a cool house in the hot season. One of the big drawbacks to galvanized iron roofs and floors is that iron is a rapid conductor of heat and cold; such houses differ considerably between their night and day temperatures and are thus detrimental to high egg yields and the general health of the flock. Thatch is the coolest for this country, but has the disadvantages that it provides shelter for the external parasites of fowls and may provide an easier entrance for wild animals.

(4) *Ease of cleaning and disinfecting.*—The need for cleanliness cannot be over-emphasized, because dirt means discomfort, encourages parasites, and leads to poorer health and lower returns. All internal fittings in a poultry house should therefore be movable so that the house and the fittings can be thoroughly cleaned and disinfected. Where houses are made of bricks, extra attention is required to see that no cracks or crevices are allowed to develop in which parasites can hide. Stone and brick houses should be whitewashed at regular intervals, and wooden houses painted with solignum or other wood preservative once a year.

Manure should never be allowed to accumulate, but should be removed regularly and added to the compost or farmyard manure heap.

(5) *Sunlight.*—Sunlight is a good germicide, and so helps to keep a flock healthy as well as drying the house. Flocks kept in dark houses are at a disadvantage over birds in a well-lighted house. For the larger types of houses the best shape is oblong with a shed roof; this allows one of the longer sides to be the front and so more sunlight can reach the floor. As the depth of a house is increased so must the height of the front, otherwise some parts of the floor never get lighted.

(6) *Floor space.*—The size of the house will be determined not only by the number of birds to be kept but also by the amount of time they are compelled to stay in the house. Overcrowding is a common fault in poultry husbandry and leads to vices and diseases. When the flock can spend the greater part of their time outside, the minimum floor space in the house should be 2 square feet per bird. A house stocked at a higher rate is definitely overcrowded.

(7) *Perches.*—The domestic fowl likes to roost off the ground and perches should be provided for this purpose. They should be two feet above the floor and should be made either from poles 1½ to 2 inches in diameter or from pieces of timber 2 inches wide and 1½ inches deep with the upper corners rounded off.

The perches should allow 8 to 10 inches of roosting space for each bird, and be fixed 15 to 18 inches apart.

(8) *Nests.*—For birds of European types the nest boxes should be from 12 to 15 inches square and about the same depth. They must be removed frequently for cleaning and disinfection, otherwise the birds are liable to get heavily infested with external parasites. At least one nest should be provided for every six birds, and too many are better than too few. Heavy-laying strains should have more nesting boxes than poorer strains. Plenty of fresh litter is another requisite.

Birds should not be allowed to lay in freshly creosoted boxes because of the risk of tainting the eggs.

(9) *Vermin-proofing.*—Houses in East Africa must be capable of keeping out wild cats, honey badgers, and similar vermin. The walls must be strongly constructed and if made of boards should not provide any cracks for predators to obtain a grip. With houses that have no floors, the walls must be continued for at least a foot below ground level, otherwise animals will burrow in.

Also efforts must be made to see that the danger from *Siafu* ants is reduced to a minimum, because these ants can cause much loss overnight.

It will usually be found that netting or expanded metal is not advisable for constructing the lower parts of the walls, unless the house is raised well out of reach of vermin.

The requirements of a good run

(1) *Dry soil.*—The run must be on well-drained soil otherwise the birds waste much energy and endure discomfort ploughing through mud. In some parts of the world, concrete, brick or other hard floors are provided, but in East Africa grass runs are more usual. The water pouring off the roof of the poultry house should be led away carefully and not allowed to spill over the runs.

(2) *Shade.*—Shade is an essential and, if no trees or shrubs are available, must be provided in the form of shelters consisting of four corner posts supporting a thatched or grass-covered roof three feet above the ground.

(3) *Adequate size.*—Unless the pen is sufficiently large, the ground quickly becomes fouled from the excreta and many internal parasites will find suitable breeding places.

It has been found practically impossible to confine birds to pens at a higher density than one to every 10 to 15 square yards if a good grass cover is to be maintained. Higher stocking rates are common, but it is at the expense of the grass cover, and since green grass is such a valuable food, efforts should be made to encourage its growth.

Many poultry keepers rest their pens at intervals; this is a good practice in that it reduces parasitic contamination of the soil.

(4) *Good fences.*—Wire-netting is usually employed to enclose the runs, and a two-inch mesh netting is suitable for fencing in adult birds. Young stock, however, require one-inch netting. Usually the fences are made six feet high, though even then light breeds, such as the Leghorn, will fly over if they can get a suitable take-off. Shelters should not be built near the fences. The wire-netting is nailed to upright posts three inches in diameter and set two feet in the ground sufficiently close together to enable the netting to be strained tightly. Some authorities allow 15-foot intervals, but others would reduce them to 7 feet.

It is a good plan to erect the posts and then stretch and fix strands of ordinary fencing wire along the tops and the bottoms of the posts. The wire-netting can then be laced to these wires to keep it taut. Some advocate a shallow trench along the bottom so that the netting can reach below ground level. If this is not done it is necessary to peg down the netting at intervals to prevent birds from going underneath.

Much trouble is sometimes encountered when two pens are separated by a common fence. The cockerels waste a lot of time trying to fight with one another, and usually damage their combs on the netting. It is a good plan in such cases to put in a partition two feet high, made from boards, galvanized iron or hessian sewn on to the netting, so that the cockerels cannot see each other.

If the house itself is well constructed, there is no point in attempting to make the runs vermin-proof. On the other hand, they must not be paced near thickets, where carnivora can hide in the daytime and pounce into the pens and carry off the birds.

For adult stock it is not usually considered necessary to cover in the tops of the runs, but for younger birds this is often advisable to prevent losses from hawks.

Materials for constructing a poultry house

No one type of house has proved superior to all others, and naturally the most economical kind should be chosen. The cost depends greatly on the materials available and on the ingenuity of the builder.

Permanent houses can be made from a number of materials. Houses with their walls built of bricks or stone are very suitable and last a long time. In other cases it may be more advisable to build the houses, including their floors, off the ground instead of with an earth, concrete or brick floor, as in stone or brick houses. For these raised houses, materials such as boards, expanded metal or iron sheets can be utilized. All are easy to work with and make good vermin-proof houses, but iron sheets suffer from the drawback of making the house hot in the day and cold at night.

The roof must be rain-proof as well as vermin-proof. For small houses the gable type is best but larger ones are better fitted with a shed roof.

Again there is a wide choice of materials for the roof. Corrugated iron is much favoured, but makes the house too hot in the daytime. When the birds live outside in the day this drawback becomes of less importance. Instead of corrugated iron, flattened cement drums can be used successfully. Some farmers may wish to use corrugated iron with an inner roof of boards to reduce the heat in the daytime.

Thatched roofs are also fairly common and make the house cool. Care is needed in their construction to build them with the correct slope (1 in 1), otherwise they will leak. The grass or straw employed should be well combed before use.

Another type of roof can be made with expanded metal covered with hessian or gunny bags, which are given two coats of cement wash. Painted canvas, which is quite rain-proof, may also be used. With these materials it is essential that white ants should not be allowed to work their way up and eat them.

In England roofs are usually made with boards and then covered with roofing felt, a method probably too expensive in this country.

At the present prices of timber, iron sheets, and expanded metal, houses of wood are cheaper than houses of iron if all the materials have to be purchased. Depending on the price of the bricks, brick houses may be cheaper than wooden ones.

Example of the foregoing principles

A farmer wishes to start poultry in a small way with a pen of 22 hens and 2 cockerels of the White Leghorn breed. He intends to keep them in an enclosed run. Twenty-four birds require a floor space of 48 square feet, perching room of 18 feet, four to six nesting boxes, and a house of 240 cubic feet air space.

There are several ways of getting these conditions, but it is probable that an oblong house with an 8 ft. x 6 ft. floor will be most suitable. For this size of house either a gable or shed roof can be used. For the former type, one with eaves 4 ft. and the apex 6 ft. from the floor gives a cubic capacity of 240 cu. ft. A shed-roofed house with the front 6 ft. and the back 4 ft. from the floor has the same cubic size. The shed type of house will use slightly more wood and will cost a few shillings more in materials.

If thatched roofs were desired, the gable roof would be much cheaper than the shed type, because the front of the latter would have to be elevated considerably to get the correct 1 in 1 roof slope, whereas the apex of the gable roof would be raised but one foot.

If burnt bricks are available at two cents each brick of 9 in. x 4 in. x 3 in., 2 in. x 2 in. timber at Sh. 2/50 per cu. ft., and ceiling board at Sh. 4/10 per cu. ft., the shed-roofed house could be built a few shillings cheaper, using brick walls and an earth floor instead of wooden walls and floor. The gable-roofed house would not be altered much in price by using bricks.

Purchased materials are expensive, and the costs of poultry houses rise very quickly unless ingenuity is shown in utilizing cheap materials. So long as the above principles are given due consideration, good types of small poultry houses can be made cheaply from the scrap material lying about all ordinary farms.

EXPERIMENTAL LEMONGRASS PLOTS IN AMANI

By R. R. Le G. Worsley, B.Sc., Ph.D., A.R.C.S., Biochemist, East African Agricultural Research Station, Amani

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The lemongrass oil of commerce is derived mainly from *Cymbopogon flexuosus* Stapf and is largely East Indian in origin. *C. citratus* Stapf also yields lemongrass oil, but with slightly different characteristics; insolubility in 70 per cent alcohol being the chief difference. This latter is the species in cultivation in East Africa. Preliminary work showed that *C. citratus* grew prolifically at Amani, could be cut about once a month, gave a good yield of oil and had a good citral content. I therefore had a plot of the grass planted out in 1934 for regular harvesting and distillation. This plot had an area of 1.2 acres, on a fairly steep slope of poor, well-drained soil, and the grass tufts were spaced 3 × 3 ft. Later, in 1936, another plot of 0.1 acres on level ground with fairly rich soil was planted with grass spaced only 9 × 9 in.

Ten cuttings in a year were obtained from each plot: the first plot was not cut initially until over a year old, when it yielded 7,000 kilos of grass, compared with the average monthly yield from later cuttings of about 600 kilos; this 7,000 kilos contained much dried-up material and the yield of oil was low. The second plot was first cut after six months, when a normal yield of grass was obtained, with a normal yield of oil.

The results are shown in Tables 1 and 2. Citral was determined by the bisulphite method; the rainfall figures give the actual rain which fell during the period from one cutting to the next, and are not the ordinary monthly records.

It will be seen that from both plots the yields of grass and of oil and the citral content all vary from month to month.

The closely spaced grass in plot 2 yielded, on the average, 10.6 times as much grass per acre as the widely spaced, but only 7.2 times as much oil, with a slightly lower citral content: the two experiments were, however, carried out in different years.

There does not appear to be any correlation between seasonal conditions and yields of grass or oil, but there seems to be one between the citral content of the oil and the rainfall during the growth of the grass.

The results show that close planting is, on the whole, advantageous. Amani is in the Usambara Mountains at an altitude of 3,000 ft.; I have no records for yields on the plains, but have been informed by one planter that he was able to cut the grass five or six times a year; the citral content of the few samples of oil from the plains that I have examined was high, one being 84 per cent.

Owing to the low prices generally prevailing for lemongrass oil, it is doubtful if it can be made an economic crop; as a supplementary crop it might possibly make a small profit.

A consignment of 90 lb. of the Amani oil was shipped to London, and after being held back for several months to find a favourable market, sold at 1s. 10d. a pound in February, 1937, this being an unusually high value at that time.

TABLE 1

1·2 acres of Lemongrass, spaced 3 ft. × 3 ft. planted April, 1934; first cutting July of following year

Cutting	Month	Yield of Grass		Yield of Oil			Citral	Rainfall
		Weight	Per acre	Weight	Per acre	Percent of grass		
		Kilos.	*Kilos.*	*Kilos.*	*Kilos.*	*Per cent*	*Per cent*	*In.*
1	July	7,000	5,830	9·50	7·92	0·136	79·5	—
2	Aug.	370	310	0·91	0·76	0·246	75·5	4·1
3	Sept.	900	750	2·17	1·81	0·241	76·0	2·2
4	Oct.	430	360	1·60	1·33	0·372	76·5	5·3
5	Nov.	640	530	2·24	1·87	0·351	75·0	1·1
6	Dec.	600	500	1·74	1·45	0·289	78·0	12·4
7	Jan.	595	500	2·40	2·00	0·403	76·0	0·1
8	Mar.	850	710	3·14	2·62	0·370	80·5	18·5
9	April	760	630	2·18	1·82	0·287	78·5	7·1
10	May	510	425	1·34	1·12	0·263	79·2	18·5
11	July	340	280	0·68	0·57	0·200	76·0	8·0
Total (excluding 1) . .		5,995	4,995	18·40	15·35	0·307	Av. 77·3	77·

TABLE 2

0·1 acres of Lemongrass, spaced 9 in. × 9 in.; first cutting after six months

Cutting	Month	Yield of Grass		Yield of Oil			Citral	Rainfall
		Weight	Per acre	Weight	Per acre	Percent of grass		
		Kilos.	*Kilos.*	*Kilos.*	*Kilos.*	*Per cent*	*Per cent*	*In.*
1	Mar.	830	8,300	1·62	16·2	0·196	77·4	—
2	April	830	8,300	1·76	17·6	0·212	77·5	13·7
3	May	460	4,600	0·96	9·6	0·208	78·9	21·9
4	July	320	3,200	0·64	6·4	0·198	77·1	12·6
5	Aug.	275	2,750	0·44	4·4	0·160	74·7	2·8
6	Sept.	370	3,700	0·60	6·0	0·163	77·8	13·1
7	Oct.	370	3,700	0·76	7·6	0·206	75·0	2·3
8	Nov.	460	4,600	0·98	9·8	0·213	75·0	3·6
9	Jan.	830	8,300	1·88	18·8	0·227	78·1	8·4
10	Feb.	550	5,500	1·21	12·1	0·209	74·9	1·9
Total		5,295	52,950	10·85	108·5	0·205	Av. 76·6	80·3

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